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THIRTEENTH ANNUAL REPORT

OF THE

OHIO AGRICULTURAL
EXPERIMENT STATION,

FOR 1894.

PRINTED BY ORDER OF THE STATE LEGISLATURE.

COLUMBUS, O.:
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1895.

TABLE OF CONTENTS.

Board of Control and Officers.

Announcement.

Report of the Secretary of the Board of Control.

Report of the Treasurer.

Report of the Director.

Report of the Agriculturist.

Report of the Horticulturist.

Report of the Entomologist.

Report of the Botanist.

Report of the Chemist.

Report of the Meteorologist.

Appendix—The Bulletin for 1894.

Index.

63.07
Oh3-3
v.13

ORGANIZATION OF THE

OHIO AGRICULTURAL EXPERIMENT STATION.

1894.

BOARD OF CONTROL.

SETH H. ELLIS	Springboro
HON. JOSEPH H. BRIGHAM	Delta
R. H. WARDER	North Bend
THE GOVERNOR OF THE STATE THE DIRECTOR OF THE STATION	*Ex-officio*

OFFICERS OF THE BOARD.

SETH H. ELLIS	President
R. H. WARDER	Secretary
BERTHA E. WILDMAN	Treasurer[1]
PERCY A. HINMAN	Treasurer[2]

STATION STAFF.

CHARLES E. THORNE	Wooster	Director
WILLIAM J. GREEN	“	Horticulturist and Vice-Director
J. FREMONT HICKMAN, M. A. S.	“	Agriculturist
FRANCIS M. WEBSTER	“	Entomologist
AUGUSTINE D. SELBY, B. Sc.	“	Botanist and Chemist[3]
BERTHA E. WILDMAN	“	Bursar[1]
PERCY A. HINMAN	“	Bursar[2]
EDWIN C. GREEN	“	Assistant Horticulturist
F. J. FALKENBACH	“	Chemist and Meteorologist[4]
CHARLES A. PATTON	“	Meteorologist[5]
J. S. HINE, B. Sc.	Neapolis	Supt. Sub-Station[6]
J. E. BARCLAY	“	Supt. Sub Station[7]

PUBLICATIONS.

The Bulletins of this Station are issued at irregular intervals. They are not republished in the annual report, but are consecutively paged and a complete index for the year's issues is published in the annual report, which constitutes the final issue for each year.

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[1] Until September 13. [2] Since September 13. [3] Since September 1. [4] Until May 1. [5] Since May 1 [6] Until April 1. [7] Since April 1.

4498
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Announcement.

The Ohio Agricultural Experiment Station is organized under an act of the General Assembly of Ohio, passed April 17, 1882, and supplemented by an act of Congress approved March 2, 1887.

The Station is prepared to test new varieties of grains, fruits and garden vegetables; to examine seeds that are suspected of being unsound or adulterated; to identify and name grasses, weeds and other plants; to identify insects and suggest measures for the control of such as are injurious, and to give advice concerning the prevention of the fungoid diseases which affect vegetation.

The Station is not prepared to furnish analyses of chemical or commercial fertilizers, as in Ohio that work is performed under direction of the Secretary of the State Board of Agriculture, at Columbus; but the Station will at all times respond to requests for advice concerning the use of such fertilizers.

The Station is not prepared to examine foods and dairy products suspected of adulteration, as that work is provided for in the Ohio Dairy and Food Commission, whose headquarters are at Columbus

The Station is not at present prepared to offer advice or treatment for contagious animal diseases, but would refer all seeking such assistance to the Ohio Live Stock Commission, at Columbus.

Any citizen of Ohio has the right to apply to the Station for any information it can give, and all such applications will receive prompt attention.

Visitors to the Station are always welcome.

Address all communications to

EXPERIMENT STATION,
Wooster, Ohio.

REPORT OF THE BOARD OF CONTROL.

To Hon William McKinley, *Governor of Ohio:*

Sir: The Board of Control of the Ohio Agricultural Experiment Station submits herewith its annual report for the year ending December 31, 1894.

The work of the Station has progressed as usual, and though the Station staff is still very much cramped for want of room and proper accommodation, several bulletins have been issued on subjects of great interest to the people of the State.

The last Legislature passed an act assuming on the part of the State the bonds issued by Wayne county to secure the location of this Station at Wooster, consequently the suit in the Supreme Court of the State to test the validity of the Wayne county bonds has been dropped. It is proper to state that this action was taken by the Legislature without consulting the officers of the Station. So far as known, not one person connected with the Station or the Board of Control favored such assumption by the State of these Wayne county bonds, and it is believed that a very large majority of the people of Wayne county would have continued to pay their taxes in good faith, and expected to redeem the said bonds, just as they had voted at the original election for the issue of bonds in order to secure the Station in this county.

The appropriations for the current year were as follows:

For 1894—	New construction	$15,000
	Tool house	500
	Sub-Station field experiments	1,500
	Special work in entomology	500
	Telephone line	200
	Expenses Board of Control	400
For 1895—	New construction	25,000
	Sub-Station field experiments	500
	Bulletin illustrations	200
	Expenses Board of Control	500

The appropriation for 1894, for new construction, has been duly expended in building the main barn, a tool house, dairy house, a large hitching shed for visitors' horses, and a dwelling house. The two tenant houses on the farm have been improved and thoroughly repaired, and the barn at the south end of the farm near the orchards has been carefully remodeled to suit the needs of the Horticulturist's work.

The telephone line, about a mile and a half in length, has been put up and four instruments purchased for the use of the Station. This puts the farm in direct communication with the town of Wooster and is an absolute necessity, especially while the office of the Station is in the city, and until the main office building, which is so greatly needed, can be built at its proper site on the farm.

The exact cost of these buildings cannot yet be given in detail, as they are not quite finished.

FURTHER EQUIPMENT NEEDED.

As stated a year ago, the Station possesses no building for its general work, although the need for such accommodations is more urgent than ever. At present the offices are in a business block in Wooster, inconveniently placed and illy adapted to the purpose. The Station's valuable books and museum collections, many of which cannot be duplicated, are exposed to loss and fire, and the work can only be carried on, while situated as at present, with great loss of time and energy.

We therefore most earnestly urge that the next Legislature shall make a sufficient appropriation to properly complete the necessary buildings of fire-proof construction, the cost of which will be about forty thousand dollars.

PERSONNEL.

The following changes occurred in the personnel of the Station during 1894:

Mr. J. E. Barclay was appointed Superintendent of the Northwestern Sub-Station, beginning April 1, vice Mr. J. S. Hine, relieved at his request.

The connection of Mr. F. J. Falkenbach with the Station was terminated in May.

Mr. Willis G. Harry was appointed Dairyman, beginning work July 1.

Miss Bertha E. Wildman resigned the position of Bursar and Treasurer of the Board of Control in September, and Mr. Percy A. Hinman was elected to this office. The Board take pleasure in testifying to the faithfulness and ability with which Miss Wildman has served the Station during the period of her connection with it.

Prof. Augustine D. Selby, B. Sc., was appointed Botanist and Chemist, his work beginning in September.

Mr. Chas. A. Patton, assistant foreman of the farm, has had charge of the meteorological observations since April.

Respectfully submitted.

R. H. WARDER, *Secretary.*

REPORT OF THE TREASURER.

To Hon. S. H. Ellis, *President Board of Control:*

Sir: I respectfully submit herewith the financial report of this Station for the fiscal year ending June 30, 1894:

In statements A, B, C and D, respectively, will be found a record of the receipts and expenditures from the various funds; statement A being a statement of account with the annual appropriation received from the U. S. Treasury, and a copy of the report made to the Governor of the State and the Secretary of the U. S. Treasury; statement B showing the receipts from farm produce and other sales, and the expenditures from this fund; and statements C and D being statements of account with the State Treasury and the donation from Wayne county, respectively.

The four statements, A, B, C and D, are combined in statement E, which shows the total income and expenditures for the fiscal year.

STATEMENT A.

THE OHIO AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES TREASURY.

Dr.

1894.		
	To receipts from the Treasurer of the United States, as per appropriation for the year ending June 30, 1894, under act of Congress approved March 2, 1887	$15,000 00

Cr.

June 30,	by salaries	$9 832 50	
"	labor	2,180 30	
"	supplies	1,672 52	
"	freight and expressage	21 00	
"	tools and implements	25 78	
"	furniture and general fittings	50 64	
"	technical apparatus	66 36	
"	library	106 06	
"	printing, postage and stationery	275 09	
"	travel and incidentals	160 29	
"	buildings	609 46	
	Total		$15,000 00

I, the undersigned, duly appointed auditor for the corporation, do hereby certify that I have examined the books and accounts of the Ohio Agricultural Experiment Station for the fiscal year ending June 30, 1894; that I have found the same well kept and correctly classified as above, and that the receipts for the time named are shown to have been $15,000, and the corresponding disbursements $15,000, for all of which proper vouchers are on file, and have been by me examined and found correct.

S. H. ELLIS,
Auditor Board of Control.

I hereby certify that the foregoing statement of account to which this is attached, is a true copy from the books of account of the institution named.

BERTHA E. WILDMAN,
Treasurer Board of Control.

STATEMENT B.

OHIO AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH PRODUCE FUND.

To Receipts.

Dr.

1894.			
June 30,	from sales of live stock	$1,803 13	
"	" agricultural produce	1,950 58	
"	" horticultural produce	1,093 08	
"	labor	28 00	
"	rent	299 66	
"	miscellaneous sales*	5,027 35	
"	Sub-stations	178 61	
	Total receipts		$10,380 41
	To balance brought forward July 1, 1893		10 78
	Total		$10.391 19

* This item includes the $5,000 received from the Ohio State University for improvements made by the station on the University farm.

By Expenditures.

Cr.

June 30,	for salaries	$50 00	
"	labor	3,658 00	
"	supplies	329 16	
"	freight and expressage	248 75	
"	tools and implements	1 27	
"	live stock	489 30	
"	fencing and drainage	1,455 13	
"	furniture and general fittings	19 78	
"	library	4 94	
"	printing, postage and stationery	35 09	
"	travel and incidentals	295 40	
"	buildings (material and labor)	1,589 48	
"	miscellaneous improvements	1,382 57	
"	Sub-stations	384 58	
	Total expenditures		$9,943 45
	By balance carried forward		447 74
	Total		$10,391 19

STATEMENT C.

STATEMENT OF ACCOUNT OF THE OHIO AGRICULTURAL EXPERIMENT STATION WITH THE STATE TREASURY.

Date of appropriation.	Appropriation for—	Total amount to the Station's credit.	Total amount expended.	Balance in treasury June 30, 1894.
1894.	Expenses of Board of Control	$400 00	....	$400 00
	Sub-station for field experiments	1,500 00	$696 74	803 26
	Special work in entomology	500 00	....	500 00
	New construction	15,000 00	....	15,000 00
	Tool house	500 00	....	500 00
	Telephone	200 00	....	200 00
	Totals for 1894	$18,100 00	$696 74	$17,403 26
	Balance of appropriations for 1892 and 1893 brought forward July 1, 1893—			
1892.	Spraying experiments	79 73	79 73	....
1893.	Expenses of Board of Control	347 78	172 38	175 40
	Sub-station for field experiments	807 62	807 62	....
	Special work in entomology	342 70	164 19	178 51
	Live stock	3,259 84	1,201 63	2,058 21
	Implements and farm machinery	1,454 15	1,123 96	330 19
	Supplies	421 40	135 59	285 81
	Totals	$24,813 22	$4,381 84	$20,431 38

STATEMENT D.

OHIO AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH DONATION FROM WAYNE COUNTY.

Receipts.

Unexpended balance brought forward July 1, 1893		$4,380 49

Expenditures.

1894.		
June 30, for land	$188 58	
" buildings and repairs of buildings	1,808 32	
" fencing	1,192 46	
" drainage	708 45	
" fruit and forest tree planting	34 38	
" miscellaneous improvements	2 00	
" legal services	446 30	
Total expenditures		$4 380 49

STATEMENT E.

TOTAL RECEIPTS AND EXPENDITURES OF THE OHIO AGRICULTURAL EXPERIMENT STATION FOR THE YEAR ENDING JUNE 30, 1894.

Receipts.

From U. S. Treasury	$15,000 00	
Farm produce, etc	10,380 41	
State appropriations for 1894	18,100 00	
Total receipts for the year		$43,480 41
Total balance brought forward July 1, 1893		11,104 49
Total		$54,584 90

Expenditures.

For salaries	$9,882 50	
Labor	5,838 30	
Supplies	2,179 40	
Freight and expressage	269 75	
Tools and implements	1,151 01	
Live stock	1,690 93	
Fencing and drainage	3,356 04	
Furniture and general fittings	70 42	
Technical apparatus	66 36	
Library	111 00	
Printing, postage and stationery	310 18	
Travel and incidentals	493 29	
Buildings and repairs of buildings	4,007 26	
Land	188 58	
Fruit and forest tree planting	34 38	
Sub-station for field experiments	1,888 94	
Special work in entomology	164 19	
Expenses of Board of Control	172 38	
Miscellaneous improvements	1,384 57	
Legal services	446 30	
Total expenditures for the year		$33,705 78
By total balance carried forward		20,879 12
Total		$54,584 90

LAND AND IMPROVEMENTS.

During the fiscal year the following amounts have been expended for additional land and for permanent improvements on the farm:

Land	$188 58
Buildings and repairs of buildings	4,007 26
Fencing	1,568 53
Drainage	1,787 51
Fruit and forest tree planting	34 38
Miscellaneous improvements	1,384 57
Total	$8,970 83

BERTHA E. WILDMAN, *Treasurer.*

REPORT OF THE DIRECTOR.

Hon. S. H. ELLIS, *President Board of Control:*

SIR: I herewith respectfully submit the thirteenth annual report of the officers of the Ohio Agricultural Experiment Station:

THE SEASON.

The season of 1894 was, in its main features, a repetition of that of 1893. The rainfall of April was below the normal, but that of May, while not above the general average in quantity, was so distributed as to interfere materially with planting. There were twenty-four days during the month in which rain fell, there being more or less rain every day except one during the last half of the month. A drouth then set in, which was quite as severe as that of the previous season in this locality, the total rainfall for June, July and August being but 3.37 inches, against an average total for the same period of 11.74 inches for the previous six years.

THE CROPS.

The yield of wheat in 1894 was generally large throughout the State and especially so in Wayne county; many yields of thirty-five to forty bushels per acre being reported. Oats gave probably an average yield, while that of corn was very low on the uplands, though good on the black soils and bottom lands where proper culture was given. A very large area was planted to potatoes, but the yield was much reduced by the drouth. Apples gave a better crop than for years in this region and there was a large crop of peaches.

These general facts regarding the season and crops are given because of their bearing upon the results of the field experiments of the year.

THE STATION'S WORK.

Eighteen hundred and ninety-four was the second year of complete occupation by this Station of its permanent home. The previous year had been devoted to fencing and drainage; this year the leading work was building, eight different buildings having been constructed or extensively repaired. This work has required almost constant attention from the Director, besides adding largely to the cares of the Agriculturist and Horticulturist of the Station. In addition to this, the Agriculturist has spent several weeks in the selection of pure bred cattle and sheep, with which to stock the Station farm. This extra work has very seriously interfered with the regular work of the Station, and has made it impossible to keep up to date with the compilation and publication of the results of the field and feeding experiments of the year. It is hoped that much of the ground thus lost may be recovered during the coming year.

Not only has the proper work of the Station been interfered with by this outside work, but it has been seriously crippled by lack of funds. Without exception, the members of the Station staff are compelled to waste a large portion of their time in the performance of merely clerical work, work which might in many cases be even better done by young men or women at one-fourth to half the present cost.

The larger part of the labor of preparing the results of a field or feeding experiment for publication consists in mere computation, this work of computation in some cases actually consuming as much time as the actual conduct of the experiment; while in the case of the Entomologist and the Botanist, the necessity for trained assistants to care for the work which they are carrying on in the insectary and bacteriological laboratory, during their necessary absences in the study of outbreaks of injurious insects or plant diseases in various parts of the State, needs only to be stated to be appreciated.

The possible value of the work of these specialists has been demonstrated, during the past year, in the warnings given of the advent in the State of the Russian thistle and the San Jose scale.

In the case of the Russian thistle, the Botanist of the Station, on receipt of a specimen from Williams county, immediately visited the locality, found that it had been introduced along the line of one of the great railways crossing the State, and at once entered into correspondence with the division superintendents of the various railway lines, all of whom expressed a sincere desire to do all in their power to prevent this new weed pest from obtaining a foothold in the State. At the request of these superintendents, several hundred copies of a special, illustrated bulletin on this weed were sent to section foremen, who were instructed to destroy the pest when found.

In the case of the San Jose scale, the Entomologist of the Station received an infested twig, sent from Clermont county; he immediately visited the locality, learned that the infested trees had come from a certain Eastern nursery, from which the pest was being distributed without any attempt at control. The prompt publication by this Station of these facts resulted in a complete change of policy on the part of the nursery referred to, and a vigorous attempt has been made to eradicate the pest.

These two are among the worst insect and weed pests known, and the prompt action of this Station has rendered it possible to prevent their obtaining a foothold in the State, provided farmers and fruit growers lend the necessary co-operation.

SUB-STATIONS.

The Northwestern Sub-station, in Fulton county, has been equipped by the thorough clearing and partial drainage of twenty acres of land and the erection of a small house and barn, and work in crop production was begun in the spring. Arrangements are being made for the establishment of a similar sub-station at Strongsville, Cuyahoga county, on the heavy clay soil which characterizes a large portion of the Western Reserve, and it is hoped that at least two more such stations may hereafter be provided for in the southern part of the State.

The problems relating to the maintenance of the fertility of the soil must take rank as of fundamental importance in any plan for the amelioration of Ohio's agriculture; but years of study must be expended upon these problems before definite results can be hoped for, because moisture and heat are as essential to crop production as soil fertility, and we must have a considerable series of observations before we can safely predict that any given result will follow a given method of treatment.

Not only must these problems be studied over a considerable interval of time, but it is necessary to include a considerable range in soils, for the physical condition of the soil is a very important factor in determining the method of its management.

PUBLICATIONS.

Six bulletins of the regular series have been issued during the year. A summary of their contents follows:

Bulletin 53, March, 1894, by C. E. Thorne and J. Fremont Hickman. Pp. 1–34.

Field experiments with commercial fertilizers, including experiments on crops grown in continuous culture, experiments on crops grown in rotation, co-operative experiments, and experiments with different carriers of phosphoric acid.

SUMMARY.

The experiments reported in this bulletin cover five years' continuous culture of wheat and oats on the farm hitherto occupied by the Station at Columbus, and belonging to the State University; six years' continuous culture of corn on that farm and in Columbiana county, and three to five years' intermittent culture of corn in Washington and Butler counties. In previous bulletins other co-operative experiments have been reported from five other counties of the State. In all, twenty-one separate experiments have been made with corn, eight with wheat and five with oats, each including fourteen to twenty-eight plots. The experiments have been made on soils varying widely in character, and including some of extreme poverty.

We are as yet only at the beginning of this work. Each year's results serve to emphasize the necessity for long continued, systematic investigation before attempting to formulate any general law; but our results thus far point most forcibly to the conclusion that:

At present prices of cereal crops and of fertilizing materials, respectively, the profitable production of corn, wheat and oats upon chemical or commercial fertilizers, or upon barnyard manure, if its cost be proportionate to that of the chemical constituents of fertility found in commercial fertilizers, is a hopeless undertaking, unless these crops be grown in a systematic rotation with clover or a similar nitrogen-storing crop; and the poorer the soil in natural fertility, the smaller the probability of profitable crop production by means of artificial fertilizers.

Drainage and thorough tillage are the logical preliminaries to any profitable system of agriculture. When these agencies of amelioration have been systematically employed, the great sheet of drift clay which covers so large a part of Ohio is found to be a mine of fertility.

BULLETIN 54, OCTOBER, 1894, BY W. J. GREEN. Pp. 35–52.

Strawberries: Cultural Notes and Comparison of Varieties.

SUMMARY.

1. Strawberries do well on almost any well drained soil which is free from frost, reasonably fertile, and not infested with white grubs.

2. There is little danger of making the soil too rich, but there is a possibility of injuring the plants with commercial fertilizers, if placed too closely about the roots, and with coarse manure.

3. Commercial fertilizers seem to have no effect on white grubs, nor does manure, but the latter stimulates the plants, so as to repair the damage.

4. The best fertilizers are well rotted manure, bone meal and wood ashes.

5. The best method of preparing the soil is to plow in the fall, mulch with manure, and fit the ground in the spring with cultivator and harrow.

6. The best time to set strawberry plants is in early spring. When plants are to be set in the fall they should be especially grown for the purpose, either in frames or in pots.

7. For matted rows the plants should be set eighteen inches by four feet apart, and for hills, one foot by three.

8. In hill culture the runners are all removed, and for the best results in matted rows a part should be cut off, or some of the plants dug out.

9. Generally, it is better to keep a bed only one season, but if kept longer the best treatment is burning soon after fruiting.

10. Winter protection should be given by mulching, and the best material is swamp hay.

11. It is not advisable to remove the mulch in the spring, either to cultivate or to avoid frost, unless the soil is very weedy.

12. The largest per cent. of good seedlings has been from crosses of the best varieties, and the smallest from seeds gathered at random.

13. A good rule in selecting varieties is to take only those that have shown the best results in many different sections, rejecting those that appear to be variable, and have exhibited weaknesses elsewhere.

14. The following are the most promising of the new varieties: Aroma, Belt's No. 3, Brandywine, Brunette, Cyclone, Granville, Huntsman ,Ivanhoe, Leader, Leviathan, Marshall, Princess, Portage, Princeton Chief, Riehl's No. 6, West Lawn, Woolverton.

15. The following are doubtful: Auburn, Beverly, Banquet, Epping, Early Bird, Gov. Hoard, Jay Gould, Lanah, Maple City, Robinson, Southard, Smeltzer's Early, Swindle, Shuckless, Timbrell, Tucker, Williams.

16. The following are poor: Eclipse, Gillespie, Michel's Early, Meek's Early, Regina.

17. The following are the best of those that have been thoroughly tested and are the cream of the list: Bubach, Crescent, Enhance, Greenville, Haverland, Lovett, Muskingum, Parker Earle, Warfield.

BULLETIN 55, OCTOBER, 1894, BY A. D. SELBY. Pp. 53-69; 3 Plates.

The Russian Thistle in Ohio and Weeds in General: This bulletin reports the introduction of the Russian thistle into northwestern Ohio, is illustrated with engravings of the thistle, and contains the laws of the State relative to weeds, black knot and peach yellows.

BULLETIN 56, DECEMBER, 1894, BY F. M. WEBSTER. Pp. 81–96; 1 Plate.

The San Jose Scale: An account of the discovery of this insect in southwestern Ohio, with life history and remedies.

BULLETIN 57, DECEMBER, 1894, BY J. FREMONT HICKMAN. Pp. 97-116.

Oats: Comparison of varieties, percentage of hull and kernl, shrinkage of grain and straw, distribution of seed, methods of seeding and notes on the smut of oats.

SUMMARY.

1. In the short, unfavorable season of 1893, the Welcome variety gave lower yields than any other of that class, while the group as a whole gave larger yields than any of the other three.

2. The Seizure oats was the lowest yielder in the whole list for 1893, where sown late, but the same variety sown four to five weeks earlier gave, the same season, as good returns as any other variety on the farm.

3 In 1894 only three varieties in the Welcome group gave higher yields than that variety, namely, Improved American, Badger Queen and Bonanza King.

4. The highest yields in the Seizure group for 1894 were from the following varieties: Japan, Early Swedish, White Swiss, Prince Edward's Island and Wilson's Prolific, the latter variety badly mixed.

5. The highest average yield was decidedly in favor of the Side-oats group.

6. In a series of tests covering four seasons, the varieties that have given the highest average yields are Improved American, Japan, Early Swedish, Prince Edward's Island, State of North Dakota, Colonel, Dakota Gray, Kansas Hybrid, Probsteier and Egyptian.

7. The average weight per measured bushel of all oats grown upon the farm during the last four years falls below the Standard of 32 pounds to the bushel. The highest average for any one variety has been 38.6 pounds, the lowest, 27 3.

8. From the investigations thus far made, it has not been found that oats of heavy weight necessarily have a smaller percentage of hull than those of lighter weight per measured bushel.

9. A single trial indicates that oats put away in good condition shrink but very little—in this instance less than one per cent.—and the straw under ordinary conditions shrinks about six per cent.

10. Experiments extending over three seasons on our clay soil show that the method of putting in oats without first plowing the ground may involve a loss of five bushels per acre as compared with sowing on land that has been plowed and well prepared.

BULLETIN 58, DECEMBER, 1894, BY C. A. PATTON. Pp. 117–127.

Meteorological Summary and Index.

Material for several other bulletins has been accumulated, but it has been impossible to prepare it for publication, owing to the pressure of other work already referred to.

Sixteen "newspaper" bulletins have been issued during the year, the substance of which has been, or will be, republished in the regular series, and two "emergency" bulletins have been issued as poster supplements to bulletins 55 and 56, these being sent to most of the postoffices in the State.

ACKNOWLEDGMENTS.

The publishers of the following journals have aided the Station in its work during the year, either by republishing abstracts from its bulletins or by donating their publications to its library:

AGRICULTURAL PAPERS OF OHIO.

American Farmer, Springfield.
American Grange Bulletin, Cincinnati.
Farm and Fireside, Springfield.
Farmer's Home, Dayton.
Gleanings in Bee Culture, Medina.
Ohio Farmer, Cleveland.

GENERAL PAPERS OF OHIO.

Arcanum Enterprise, Arcanum.
Ashtabula News, Ashtabula.
Attica Journal, Attica.
Auglaize County Democrat, Wapakoneta.
Bakersville Press, Bakersville.
Barnesville Republican, Barnesville.
Cincinnati Price Current, Cincinnati.
Columbus Record, Columbus.
Cortland Herald, Cortland.
Crestline Advocate, Crestline.
De Graff Buckeye, De Graff.
Democratic Herald, Delaware.
Democratie Record, Chardon.
Forest Review, Forest.
Frederickstown Free Press, Frederickstown.
Fremont Journal, Fremont.
Geauga County Record, Chardon.
Geauga Leader, Burton.
Greenville Democrat, Greenville.
Herald, Middleport.
Industrial News, Toledo.
Jacksonian, Wooster.
Kenton Graphic News, Kenton.
Leader, Chillicothe.

Lewisburg Reporter, Lewisburg.
Lodi Review, Lodi.
Malta Register, Malta.
Monroe Journal (German), Woodsfield.
New Concord Enterprise, New Concord.
Northern Ohio Journal, Painesville.
Ohio State Journal, Columbus.
Painesville Telegram, Painesville.
Plain City Dealer, Plain City.
Press, Columbus.
Republican Leader, New Lisbon.
Shelby News, Shelby.
Tuscarawas Advocate, New Philadelphia.
Tuscarawas Chronicle, Uhrichsville and Dennison.
Union County Journal, Marysville.
Valley Enterprise, Milford.
Wayne County Democrat, Wooster.
Wayne County Herald, Wooster.
Wood County Democrat, Bowling Green.
Wooster Republican, Wooster.

MISCELLANEOUS PAPERS.

Agricultural.

Acker und Gartenbau Zeitung, Milwaukee, Wis.
Agricultural Epitomist, Indianapolis, Ind.
Agricultural Journal, Montgomery, Ala.
Agricultural Gazette, New South Wales.
American Agriculturist, New York, N. Y., and Columbus, O.
American Dairyman, N. Y. City.
American Gardening, New York, N. Y.
American Homestead, Omaha, Neb.
American Rural Home, Rochester, N. Y.
Breeders' Gazette, Chicago, Ill.
California Cultivator and Poultry Keeper, Los Angeles, Cal.
Canadian Entomologist, London, Ont., Canada.
Colman's Rural World, St. Louis, Mo.
Cultivator, Omaha. Neb.
Dakota Farmer, Huron, South Dakota.
Dorset Quarterly Washington, Pa.
Elgin Dairy, Elgin, Ill.
Farm and Home, Chicago, Ill., and Springfield, Mass.
Farmers' Advocate, London and Winnipeg, Canada.
Farmer's Magazine, Springfield, Ill.
Farm, Field and Fireside, Chicago, Ill.
Farm, Stock and Home, Minneapolis, Minn.
Florida Agriculturist, De Land, Fla.
Fruit Growers' Journal, Cobden, Ill.
Gardening, Chicago, Ill.
Grange Visitor, Lansing, Mich.
Hoard's Dairyman, Ft. Atkinson, Wis.
Home and Farm, Louisville, Ky.
Industrial American, Lexington, Ky.
Indiana Farmer, Indianapolis, Ind.
Jersey Bulletin, Indianapolis, Ind.

Journal of Agriculture, St. Louis, Mo.
Maritime Agriculturist, St. John, N. B.
Mirror and Farmer, Manchester, N. H.
National Stockman and Farmer, Pittsburg, Pa.
Orange Judd Farmer, Chicago, Ill.
Pacific Rural Press, San Francisco, Cal.
Practical Farmer, Philadelphia, Pa.
Prairie Farmer, Chicago, Ill.
Rural New Yorker, New York, N. Y.
Rural Northwest, Portland, Oregon.
Southern Cultivator and Dixie Farmer, Atlanta, Ga.
Southern Planter, Richmond, Va.
Stock and Farm, Bunker Hill, Ind.
Sugar Beet, Philadelphia, Pa.
Weekly Globe and Canadian Farmer, Toronto, Canada.
Western Breeder, St. Joseph, Mo.
Western Farmer and Stockman, Sioux City, Iowa.
Western Resources, Lincoln, Neb.
Western Swineherd, Geneseo, Ill.
Wisconsin Farmer, Madison, Wis.

General.

Baltimore Weekly Sun, Baltimore, Md.
Clover Leaf, South Bend, Ind.
Detroit Free Press, Weekly, Detroit, Mich.
Kansas Weekly Capital and Farm Journal, Topeka, Kansas.
National Provisioner, New York, N. Y.
Press, The Weekly, New York, N. Y.
Press, The Weekly, Philadelphia, Pa.
Science, New York, N. Y.
University Record, Ann Arbor, Mich.
Union, The Weekly, Manchester, N. H.
World, The Weekly, New York, N. Y.

IMPLEMENTS, SEEDS AND PLANTS RECEIVED.

Thanks are returned for the following donations to the Station:

AGRICULTURAL DEPARTMENT.

Superior Surface Cultivator, presented by Nicholas Roggy, Princeton, Ill.
One Universal plow, presented by Universal Plow Co., Wooster, O.
One coal bag, presented by William T. Lane, Port Chester, N. Y.
Two plow points, presented by Cushman & Blaser, Shreve, O.
One gallon of seed corn, Huntingden Seed Co., Indianapolis, Ind.
One Holstein Friesian bull, presented by W. B. Smith & Son, Columbus, O.
One Guernsey bull, presented by R. H. Warder, North Bend, O.

HORTICULTURAL DEPARTMENT.

Alwood, W. B., Blacksburgh, Va., four varieties of tomato seed.
Anderson, W. F., Hillsboro, O., one variety of tomato seed.
Burpee, W. A. & Co., Philadelphia, Pa., thirty-three varieties of vegetable seed.
Bixler, C. G., Three Rivers, Mich., one variety of strawberry plants.
Baird, W. C., Ashtabula, O., one variety of plum buds.
Cone, E. W., Menomonee, Wis., two varieties of strawberry plants.

Chrysty, J. W., Pataskala, O., one variety of potato plants.
Cowen, Ross, Barnesville, O., one variety of strawberry plants.
Calhoun, J. W., Savannah, O., one variety of potato.
Clark, M. W., Kent, O., two varieties of strawberry plants.
Ellis, M. I., Norwood, Mass., one variety of raspberry plants.
Everitt, J. A., Indianapolis, Ind., six varieties of potatoes.
Farmer's Nursery Co., Tadmor, O., one variety of peach tree.
Gault, W. C., Ruggles, O., one variety of raspberry plants.
Horner, Joel & Son, Delair, N. J., one variety of grape.
Longenecker, Theo. F., Dayton, O., one variety of raspberry plants.
Lincoln, B. F., West Hingham, Mass., one variety of strawberry plants.
Moyer & Cook, Lake'on, Ind., one variety of apple tree.
Mumma, A. L., Mechanicsburg, O, one variety of strawberry plants.
Mohler, D. M., New Paris, O., one variety of blackberry plants.
Marshall & Long, Augusta, O., one variety of peach tree.
Oberholzer, John, Levering, O., one variety of strawberry plants.
Thompson, M. T., Rio Vista, Va., seven varieties of raspberries and one of strawberry plants.
Tate, W. E., Evergreen, Alabama, one variety of strawberry plants.
Taylor & Downs, Columbus, O., one Buckley Garden Cultivator.

The Superior Cultivator is a very good implement for surface cultivation, and when properly handled it does its work with ease, both to man and horse. It is not a perfect implement, but is perhaps as good as any made up to date. It is another step toward a perfect tool.

The Universal plow is a very satisfactory implement for our soil.

The coal bag we find convenient for many purposes.

The Garden Cultivator is an excellent implement for use in small gardens.

The seeds, plants and trees will be reported upon in future bulletins.

Respectfully submitted.

CHAS. E. THORNE, *Director.*

REPORT OF THE AGRICULTURIST.

J. Fremont Hickman.

The past year has been devoted mainly to a continuation of the several lines of work noted in my report of last year, namely, tests of varieties, including wheat, oats and corn; cultural work with cereals and forage crops; field experiments with commercial fertilizers in continuous cropping and in rotation. The winter season has been occupied in preparing for and attending farmers' institutes, in looking after live stock, and conducting feeding experiments and planning work for the summer.

The testing of varieties of grain, roots and forage crops has always been one of the leading lines of experiment work at this Station, and the constant inquiries from farmers of all parts of the State give marked evidence that it is at present one of the most popular and instructive branches of our field work.

Inquiries by letter and questions asked at farmers' institutes show that a growing proportion of the farmers are interested in the growing of forage crops. To meet these questions the work of the previous year was repeated by putting out a number of plats of various kinds of such forage plants as seemed most likely to succeed on our soil. This list consisted of four varieties of soy beans, the seed of which came from Japan; two varieties of soy beans, American grown seed; two varieties of sesame; one variety of New England cow pea; four varieties of rape; one of teosinte; red and white Kaffir corn; Jerusalem corn; Russian millet; alfalfa; spurry; crimson clover and Lathyrus sylvestris.

The grass garden mentioned in last year's report was very much enlarged by adding quite a list of varieties early in the spring but the dry season following has killed nearly, if not quite, all of them, together with the several kinds of clover that had gotten nicely started.

In addition to the cultural and variety tests with corn, four plats were used, two of which were manured early in February, the other two in April, the object being to show the results of winter and spring applications of fresh barnyard manure.

EXPERIMENTS WITH COMMERCIAL FERTILIZERS.

This line of tests is now fully started on the Station farm, so that during the past year we have had results from thirty plats each of corn, oats and wheat. Next year we shall have thirty of grass following wheat in the regular five-year rotation. In addition to these we have for continuous cropping after the application of fertilizers, ten plats each for corn, oats and wheat.

The work of former years has been continued at the Ohio State University, under direction of this Station, both in continuous cropping with corn, oats and wheat, and with the five-year rotation. The experiment in Columbiana county, in which the Station has been applying commercial manures to corn continuously for six years, was continued during the past season, but on account of the constantly decreasing yield in the crop, year after year, the application for the season of 1894 was doubled. The results do not indicate that the extravagant application was followed by a proportionate increase in yields.

FEEDING EXPERIMENT.

The thirty-two steers on hand January 1, 1894, were put into a feeding experiment early in the month; they were divided into eight sets of four each; no two sets of four were fed on exactly the same kind of feed, the object being to determine the cost of putting on flesh with the different kinds of feed. The following feeds were used: Gluten meal, wheat meal, linseed oil meal, corn meal, wheat bran, corn silage, clover and timothy hay. The feed given each day was weighed, and if any remained the following morning not eaten it was weighed and deducted from the amount fed the previous day. This experiment was continued six months, at the end of which the cattle were shipped to the Pittsburgh market and sold. Soon after, seventeen two-year-old steers were bought and put upon the farm, preparatory to putting them into a similar experiment this winter. The results of both experiments will be published in a future bulletin.

THE DAIRY.

The selecting and getting together three representative cows and a bull of each of six breeds, between the ages of three and seven years, has proven to be no small undertaking. It was expected that the several breeders' associations of the State would do the most of this work, but only two of the six breeds to be represented were found to have State organizations; one of these, the Jersey association, appointed a committee of one, Col. A. T. Dempsey, of Columbus, to help select the Jerseys. Col. Dempsey rendered valuable assistance in the work; in fact, did all he could in making good selections for the Jersey breeders and for the Station. We (Director Thorne and myself) found all breeders whose herds we visited, or with whom we had any correspondence, thoroughly interested and willing to give us any assistance possible.

The following gentlemen have given us special help in the work: Capt. V. T. Hills, Delaware, and J. McLain Smith, Dayton, Red Polled breeders; O. E. Bradfute, Cedarville, and J. P. Hine, Shinrock, Aberdeen Angus breeders; E. F. Smith, of Columbus, a Holstein breeder, spent several days in helping select the Holsteins; his knowledge of the breed and acquaintance with the breeders of the State was an invaluable aid in this special line.

In selecting the Shorthorns and the Guernseys we had to depend largely upon our own judgment, yet the breeders of those cattle, as well as the others, were impressed with the fact that if inferior animals got into this test the result would be very much more disastrous to their breed and to their individual interests than it could possibly be to the Station.

We now have in the Station barns the four individuals of the six breeds except one Guernsey cow, and this one we have in view. Some experiments with the breeds are already under way; the milk of each animal is carefully weighed, the amount of feed given is weighed and a record kept.

The amount of feed given and consumed by each calf is also weighed and recorded. Experiments of a more comprehensive nature will be taken up as soon as the dairy building is more fully equipped. For the satisfaction of all interested, the pedigrees of the several animals purchased will be published in due time. It may be well to add that all these cattle were bought within the State; all are registered animals, and we believe that we have very fair representatives of the several breeds.

SHEEP FLOCKS.

On a plan similar to the above, and with a like purpose in view, five breeds of sheep have been placed upon the farm. As with the dairy cows, it was desirable to have as many representative animals in each breed as the funds set apart for the purpose would purchase. The sheep breeders, like the cattle men, realized that the proposed experiment must be an interesting and an instructive one, and from the first mention of the proposed test exhibited a lively interest, and have given every possible encouragement to advance the start. Like getting the cattle, the selecting of the sheep has required considerable time and travel. We now have eight ewes and a ram of each of the following named breeds: Southdowns, Oxfordshires, Shropshires, Dorset Horned and Delaine Merinos. These sheep are all registered. One-half of each eight ewes are rising two year old and the other four are rising three. While the Station buildings are not adapted to the purpose, we hope to arrange to do some comparative work in feeding this winter.

FARM IMPROVEMENTS.

Much of my time was occupied during the summer in superintending various improvements on the farm, including the removal and complete remodeling of two old houses, grading around these and other buildings, the construction of a cattle culvert, the drilling of several wells, constructing cisterns, etc.

FARM PRODUCTS.

In the following table is given the area of land occupied by the several farm crops in 1894, the total and average yields per acre, and the price per unit in the Wooster market at the close of the year. This table is given more for future reference than for any interest that it may have at this time:

Crop.	Acres.	Total produce.	Yield per acre.	Market price.
Wheat	49	882 bushels	18 bushels	$0 52
Wheat straw		65.9 tons	1.34 ton	3 00
Oats	29	1,160 bushels	40 bushels	33
Oats straw		24.4 tons	0.84 ton	3 00
Corn	26	780 bushels	30 bushels	39
Corn stover		37.5 tons	1.5 ton	2 50
Ensilage corn	8	72.0 “	9.0 tons	
Hay timothy	52	85.0 “	1.63 ton	9 00
Hay clover	18	27.0 “	1.5 ton	8 00

The corn stover, ensilage corn, clover and timothy hay from the farm were not all weighed, but enough of each to give very close estimates; the wheat, oats and corn, together with the straw, are as near correct as the scales can make them. The low yield of corn was due to a lack of rainfall at earing time; the yield of wheat was reduced about one-fourth, partly on account of treating the seed, but more as the result of very dry weather immediately after sowing; this will be explained more fully in our next wheat bulletin.

REPORT OF THE HORTICULTURIST.

W. J. Green.

The work of the Horticultural Department has progressed during the year in a satisfactory manner, except so far as it has been unfavorably affected by the extreme dry weather.

The work in the green-houses has been carried on continuously, although during July and August the greater part of the space was unoccupied. Almost the entire space in four houses has been given up to experiments in sub-irrigation. Lettuce, radishes and tomatoes are the vegetable crops most largely grown, and a report on the first and second is now nearly ready for the printer.

Although we have had fair success in growing tomatoes under glass in previous years, last season's operations were more satisfactory than any before, the results showing somewhat unexpected possibilities in the way of sub irrigation for this crop. The matter is to be more carefully studied the coming season, and it is hoped that a bulletin on tomato culture under glass can be prepared next fall.

The Horticulturist spent a week in visiting gardens in the east where vegetable forcing is largely practiced, with a view to comparing methods, in order to determine if any change in our present plan is desirable. The belief, held before the visit, was confirmed, that methods must be adapted to the locality. The gardener who follows eastern methods in forcing vegetables for western markets will fail, as the demands in the two localities are radically different, and there is a great dissimilarity in the soils also.

Boston and other eastern markets will take head lettuce only, while the western cities are satisfied with Grand Rapids, which can be grown more easily and cheaply. Cucumbers are grown after lettuce there, but tomatoes yield a better profit here. The soil there is of such a character that continued watering on the surface has no injurious effect upon it, but our clay soils soon become compacted, so that not more than one crop can be grown upon them successfully, except by sub-irrigation. In fact, we have pretty clearly shown that good crops cannot be grown in the green-house, with clay soil, if surface watering is practiced.

It amounts to this, then, that sub-irrigation makes it possible to use soil for vegetable forcing that could not profitably be employed by the ordinary method, and the territory for such work is thus greatly extended.

Observations made during the visit also confirmed the belief that the business of vegetable forcing could profitably be extended in this State, and that our present plan of growing lettuce in the early part of winter, following with tomatoes as a spring and summer crop, is the best plan for this section.

Experiments in growing roses, carnations and smilax by sub-irrigation have not been completed, owing partly to the destruction of the roses by nematodes. The nematodes have, however, been much less troublesome on the sub-irrigated plants than upon those that were surface watered. It seems to be well established that bench drainage is not necessary; at least no plants have been injured by sub-irrigating on water-tight benches, and all kinds uniformly do better when grown in this manner than by the ordinary method. Mr. E. C. Green has devised a plan by which sub-irrigated beds may be drained of surplus water if need be, but thus far we have found no necessity for drainage, nor for taking any special pains to prevent over-saturation of the soil.

In the bulletin on sub-irrigation above mentioned, the following propositions are elaborated.

(1.) Watering by sub-irrigation, in the green-house, is more cheaply done than by the ordinary method.

(2.) Watering by sub-irrigation, in the green-house, is more efficiently done than by the ordinary method.

(3.) Where sub-irrigation is practiced, in the green-house, the soil does not become compacted as by surface watering, but retains its original loose, friable condition, even without frequent stirring, nor does it become soggy, water-logged or sour, nor does the surface become mossy.

(4.) Plants are less liable to suffer from over watering where sub-irrigation is practiced than where the water is applied to the surface, and in some cases there is less liability to disease.

(5.) All classes of plants, which may be grown on green-house benches, do better by sub-irrigation than by surface watering.

In support of these propositions the results with lettuce and radishes are given, while the experiments with other classes of plants are left for future publication. Some instructions are also given in methods of construction of water-tight benches.

But little attempt is made to grow plants in the green-houses for ornament alone, for want of means and suitable space. Mr. W. A. Porter, who has charge of this department, has, however, grown some very fine specimens of various classes of plants, especially chrysanthemums, which were admired by the many visitors who saw them. It does not seem out of place to minister to the pleasure of visitors in this way, but such work must necessarily be kept within close limits, as there is so much else that is pressing,

The fruit plantations have been considerably extended by the addition of new varieties. The trees and plants are in good condition, having made a satisfactory growth, except strawberries, which suffered for want of rain. The strawberry crop was quite good, and afforded opportunity to compare varieties, a report of which was made in the October Bulletin, No. 54. In the same bulletin some cultural notes were given, and responses show that they have been helpful to many. Raspberries, and perhaps currants and gooseberries, are to be treated the same manner next season, as the plants will then be old enough to yield full crops.

A field of about ten acres was laid out in tenth acre plots for rotation experiments with potatoes, wheat and clover. The south tier of plots was planted with potatoes, and the first set of fertilizer experiments of the rotation started. The same tier of plots was sown to wheat, and is to be seeded with clover in the spring.

Variety tests of potatoes were conducted on a larger scale than usual. Except in a few cases where the stock was limited, a row 272 feet long was devoted to each variety, and all were duplicated.

In order to get sufficient ground in one body for the rotation work, it was necessary to clear about five acres of land, which was covered with stumps and small trees. This work was not quite finished, but will be before next spring. This new land is so situated that the plots are not affected unequally, and will give opportunity to study the problem of keeping up as well as of restoring the fertility of the soil. A number of other crops were grown, preliminary to other work in the future.

Considerable work has been done in clearing away old fences and buildings, both for the sake of convenience and appearance. The barn which belongs to the department has been repaired, and will be completely remodeled. A cold storage room has been fitted up in one end, and as all of the underground stable is not needed for stock, it is designed to make a frost proof room adjoining the cold storage room, leaving sufficient space for all animals which are likely to be kept. A tool room has been fitted up in one end of the barn, and some other minor improvements made. The vegetable garden has been put into better condition by heavy manuring and tiling. On the whole, the department is in good shape for future work.

REPORT OF THE ENTOMOLOGIST.

F. M. Webster.

So far as facilities for original investigations are concerned at the Station, the conditions have not changed for the better from last year. The appropriation made by the Legislature for special work in entomology enables me to carry on investigations in fields and orchards at a distance, but offers no relief for the necessary requirements at the Station itself, in case work is attempted there Besides, outside investigations and institute work require prolonged absence from the Station, which, as every one knows, is wholly incompatible with the carrying out of continuous experiments that require both careful and constant attention, if, as in my case, no trained assistance is available. The requirements for this department are not necessarily expensive, but the entomologist is dealing with organisms over whose movements he has not the least control, and unless necessary facilities are at hand promptly when needed, their lack will and does, often, end in the loss of the results of weeks or even months of patient study, besides a monetary sacrifice the amount of which is wholly out of proportion to the cost of the facilities required. Entomological publications and current entomological literature, which makes the intelligent use of this special appropriation possible, are furnished almost entirely at my personal expense.

A very large portion of the special appropriation for the year 1894, was expended in investigating the habits and methods of repression of the first two of the species of insects mentioned in the following pages.

During the winter complaints were received of serious injury to the dewberry, the growing of the fruit of which has, in Southern Ohio, developed into quite an extensive and profitable industry. A visit to the region of depredation revealed the depredator in the Gouty-gall beetle of the raspberry, *Agrilus ruficollis* Fab., fully treated as a raspberry pest in Bulletin 45, pp. 191–93, of this Station. In order to carefully watch the pest, with a view of preventing future ravages, several trips to Hamilton county were made during the spring and summer. It was learned that the eggs are deposited in the young growth, near the surface of the ground, and the larvæ from these eggs finally so injure the plant that it either dies before the following spring, or is so weakened by the attack that it produces little fruit and that of an inferior quality. These beetles appear about the middle of May and remain until the last of June, or about the time of the ripening of the first berries. From all that I have learned of the pest and the nature of the plant attacked there seems every probability that this injury can be prevented by cutting out the new growth appearing prior to the ripening of the earliest berries, and at this season, thus depending upon a second growth, which will be free from attack, to furnish the bearing wood for the next year.

By far the larger part of the special fund and a large per cent. of my own time for several months was employed in investigating the habits of a beetle whose larvæ were very destructive to grapes, and whose ravages occurred in the extensive vineyards of Eastern Cuyahoga and Western Lake counties. The injury was found to be due to the attacks of the larvæ of *Fidia viticida*, an insect that had been known for almost thirty years, yet nothing had been learned of its habits or of the nature of its earlier stages, much less of its destructive habits during such stages. A year's study has shown that the larvæ or grubs pass the winter in the ground about the roots of the grapes from which they have fed the previous summer and fall, and that only such as appeared very late in the season return to the roots in order to feed in the spring; that these larvæ pupate, largely at least in June; that the eggs are deposited under the bark of the vines, largely during July, but scattering along through August; that the larvæ on hatching drop to the ground and enter it, feeding on the bark of the roots, and gradually working their way downward and outward from the vines, with the result that the latter sustain serious injury or are killed. No natural enemies of the beetles were discovered, though these feed on the upper surface of the leaves and make no effort toward concealment; nor were any enemies observed attacking the larvæ or pupæ, but the eggs were destroyed by no less than five natural enemies. A mite, possibly *Tyroglyphus phylloxeræ*, a smaller mite resembling *Hoplophora arctata*, the little brown ant, *Lasius brunneus*, var. *aliens*, were all observed feeding upon the eggs, while two species of minute four-winged flies, *Fidiorba flavipes* Ashmead and *Brachysticha fidiæ* Ashmead, were reared from the eggs of the beetle. The first is new as to both genus and species, the last new as to species, and described for the first time in a paper published by myself in the Journal of the Cincinnati Society of Natural History for October, 1894.

A large number of experiments were carried on in the vineyards with various insecticides for the purpose of destroying these insects. The arsenites, to be effective, must be used very early, before all of the beetles have appeared, and too strong to warrant their use after the middle of July, on account of injury to the fruit. Bi-sulphide of carbon has been tried in early spring and on a limited scale, with good results, while later in summer and when the ground was very dry, the results were less satisfactory. Further experimentation will be carried on with the coming spring, and all results will probably be combined with what has been learned of the habits of the pest, and embodied in a separate bulletin, to be issued as soon as the desired data has been secured, probably sometime during the summer.

A study of the distribution of the Western Corn Root-worm in Ohio has resulted in its being found in the valleys of the Little and Big Miamis, the Upper Wabash and the Upper Maumee rivers. (See Fig. 1.) This insect is treated at length and fully illustrated in Bulletin No. 51, pp. 89–96.

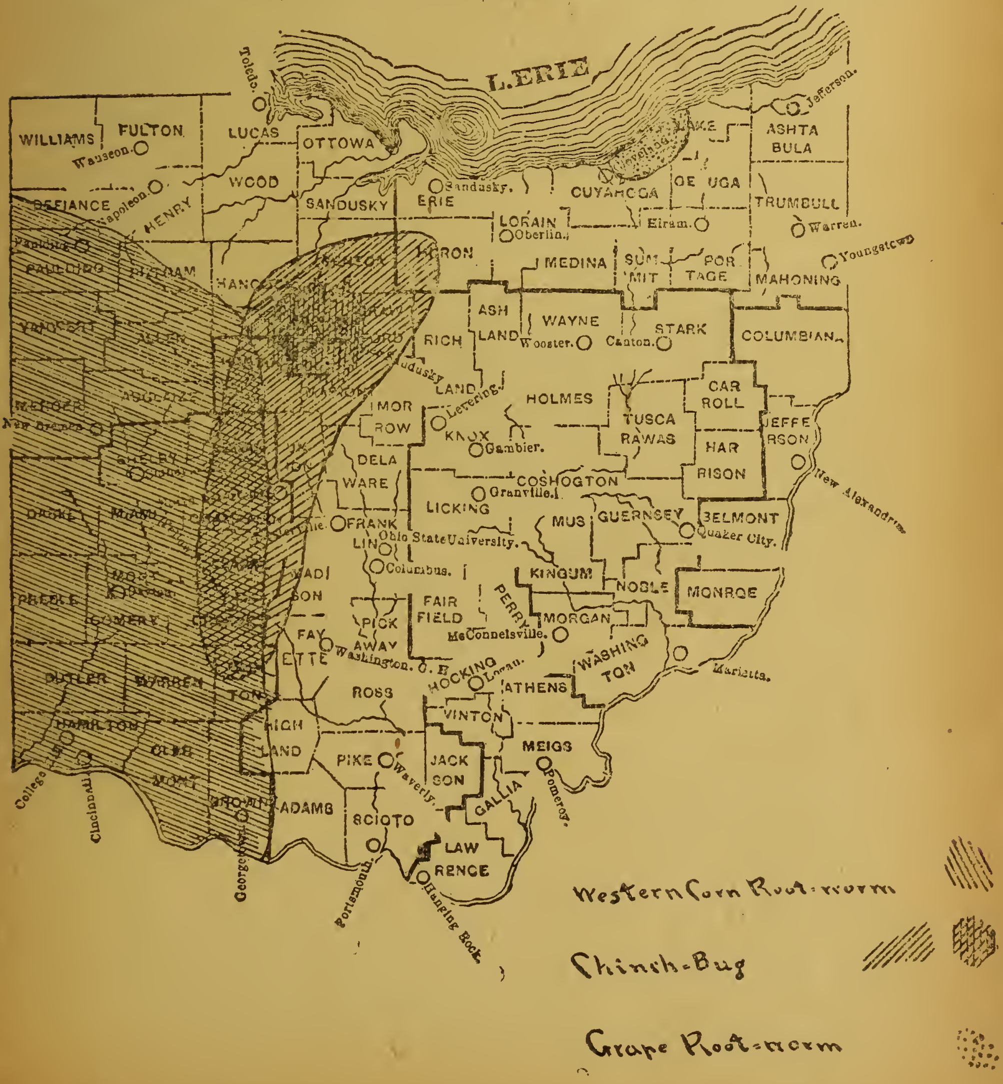


FIG. 1. Showing known distribution of *Diabrotica longicornis, Blissus leucopterus* and *Fidia viticida*, in greater or less abundance in 1894.

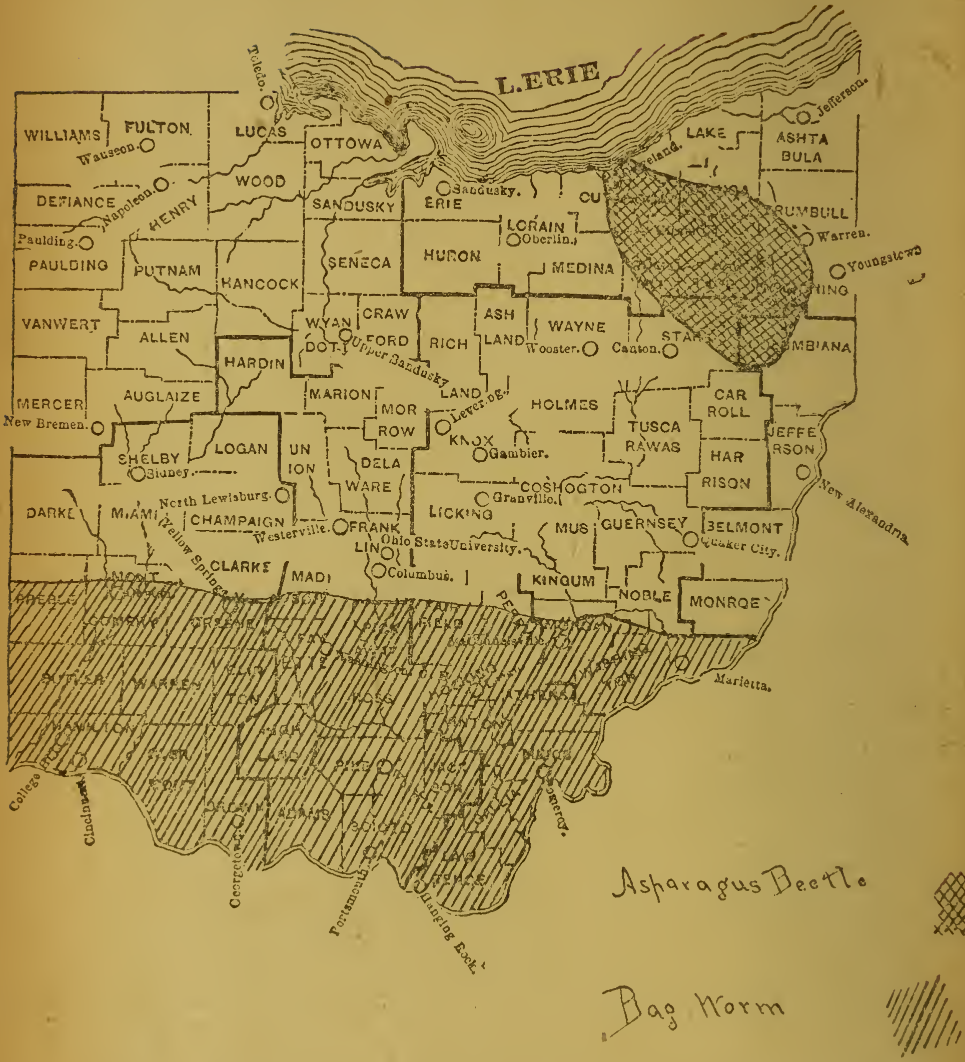


Fig. 2. Showing known distribution, in Ohio, of *Crioceris asparagi*, and *Thyridopteryx ephemeræformis*, in 1894.

An invasion of chinch bug, *Blissus leucopterus*, Say, was studied and its area mapped out as far as possible to do so. The infested section (see Fig. 1) included the following counties, with the "storm centre," so to speak, in Wyandot county about Upper Sandsuky: Clark, Champaign, Logan, Hardin, Hancock, Seneca, Crawford and Marion. Close watch will be kept on the pest in the section above indicated during the coming year.

An invasion of the Asparagus beetle has also received attention and is now known to cover in part or all of the following counties: Columbiana, Mahoning, Trumbull, Portage and Cuyahoga. See Fig. 2. This pest known to science as *Crioceris asparagi*, Linn, is gradually spreading westward, and a full description of both the pest, its movements, remedies, etc., may be found in Bulletin No. 51, pp. 86–89.

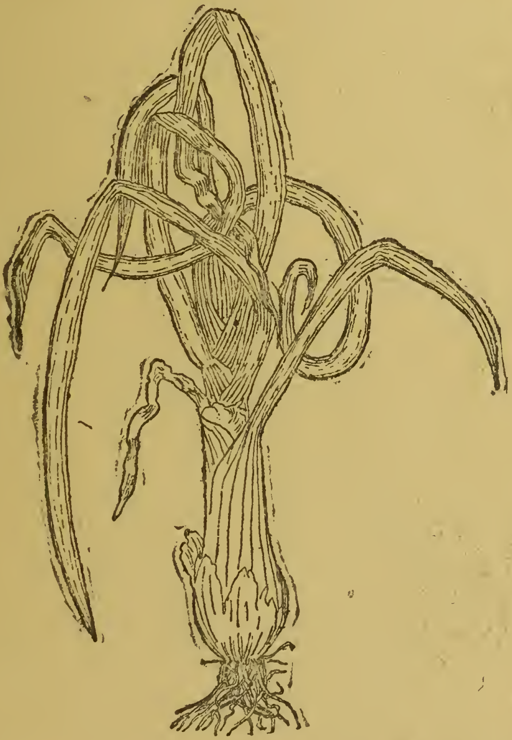


Fig. 3. Appearance of onion attacked by Onion Thrips, *Limothrips tritici.*

The White Blast of the onion, due to attacks of the Onion Thrips, *Limothrips tritici*, Packard, as determined for me by U. S. Entomologist, L. O. Howard, and which caused much damage to this crop over the State, especially on uplands, has received considerable attention. Remedial measures were tried in the fields, late in the season, without satisfactory effect. A quantity of material is being kept in the insectary for study through the winter, and the matter will be followed as far as the facilities offered will permit. See Fig. 3.

Late in December, 1894, an outbreak of the San José Scale was investigated in Clermont county. The lateness of the season has rendered it necessary to postpone all operations on this insect until spring. In the meantime an emergency poster bulletin and a regular Station Bulletin, No 36, relating to the pest have been issued for the benefit of the people.

The only work of importance that has been carried out to completion in the insectary, consisted in the following out of the life history of the Strawberry worm, *Harpiphorus maculatus*, Norton. While in Indiana, I had for several years observed the larvæ on strawberry plants, early in July, in the garden of Hon. E. H. Scott, Mayor of LaPorte, Ind., to whom I applied last year for specimens. From such, kindly furnished me by Mr. Scott, I was able to follow out their history. In this garden the larvæ appear each year with or a little before the ripening of the earliest berries. In my studies, I found that this was the rule and that there was but one annual brood, whereas there were said to be two.

A new fruit tree enemy was found in Southern Ohio, in the shape of a large gray bug, *Brochymena annulata*, Fab., which attacks young fruit trees, especially apple and plum, sucking the sap from the tender wood and causing it to wither and die. These bugs were observed also attacking the twigs of Larch on the grounds of Mr. R. H. Warder, of North Bend. The pest is a common one, though it had but once before—in May of last year—been known to attack fruit trees, and this was in Virginia.

The following insects have claimed more or less attention: The Northern Mole cricket, *Gryllotalpa borealis*, Scudder, has been reported from two widely distant localities as depredating on vegetables in gardens and especially potatoes. A sudden visitation of the Pear Blister beetle, *Pomphopœa ænea*, Say, seriously injured pears in the neighborhood of Mineral Point, by eating off the bloom. A white maggot, larvæ of *Phorbia fusciceps*, Zett., was quite destructive to growing beans in Western Ohio, the real depredator being determined by rearing from infested plants transferred to the insectary. This, as seems from some recent studies made at the Department of Agriculture, to be identical with the Seed Corn maggot, which sometimes destroys seed corn, after planting. It had only been reported as injuring beans about Quebec, Canada. Two entirely new cabbage insects were observed in the extreme southwestern part of Wayne county. A field of low, swamp land has been underdrained and brought under cultivation, being devoted to cabbage. The most common plant growing naturally on this ground had been water plantain, in which the two snout beetles, *Listronotus appendiculatus* Boh. (the development of a closely related species is shown in Fig. 4), and *Erycus puncticollis*, Lec., probably originated, both of which I myself saw gouging out great cavities in the stems and bases of the leaves of cabbage plants (see Fig. 5). It was noticed that where the water plantain had been kept from growing, up to the time of planting out of the cabbage plants, little injury had been done, otherwise the loss

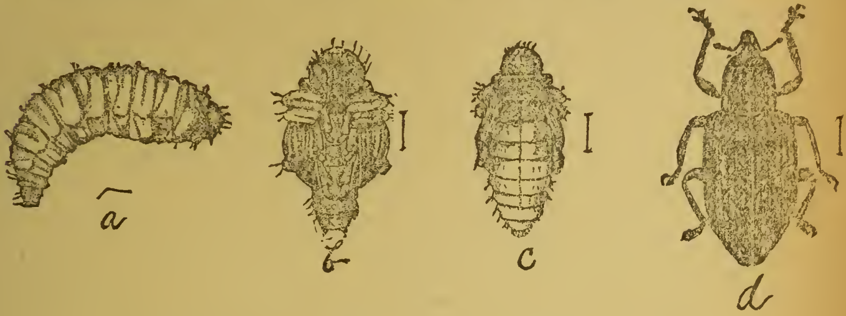


FIG. 4. The Sagittaria Curculio. (*Listronotus latiusculus*, Boh.)
a. Larva. Enlarged. *c.* Pupa, dorsal view. Enlarged.
b. Pupa, ventral view. Enlarged. *d.* Imago. Enlarged.

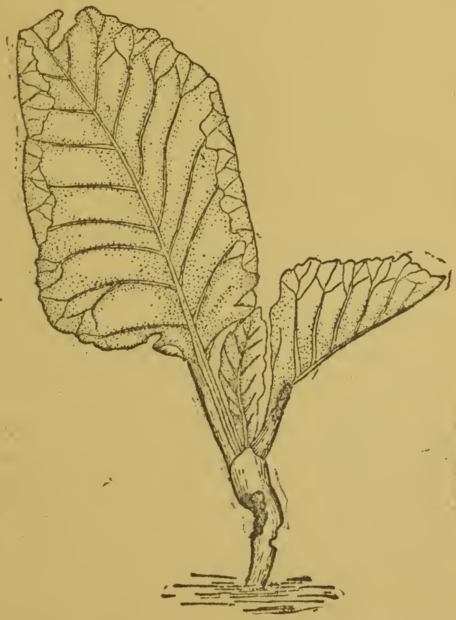


FIG. 5. Showing young cabbage plant attacked by *Listronotus appendiculatus* and *Erycus puncticollis.*

had been considerable. The flea-like Negro bug, *Corimelæna pulicaria*, Germ., described and illustrated in Bulletin 45, p. 211, of this Station, was reported as injuring celery about Marchand, Ohio, the pest being present in great numbers. A great abundance of the Flavescent Clover weevil, *Sitones flavescens*, Marsh, studied by me at Lafayette, Indiana, and the results given in the report of the Commissioner of Agriculture for 1886, pp. 580–82, was reported from Neowash, Ohio, as occurring in clover fields at time of cutting the seed. This may be looked upon as a possible clover pest of the future. Serious injury from attacks of the potato stalk borer, *Trichobaris trinotata*, Say, have been received from Ottawa county, and we are inclined to believe that this pest is on the increase in Ohio. It is now being studied in the insectary.

The only field experiment carried on at the Station grounds was that of spraying to determine the effect on bees, if done during the blooming season. This was really a continuation of an experiment begun at Columbus, and resulted in proving that bees may be poisoned in this manner, and also that the young brood may be destroyed by poison carried from the sprayed trees. It is probable that by spraying in cold or damp weather, when bees are abroad but little, the effect is not so fatal; but under favorable circumstances it is not only necessary that the most of the bloom shall have fallen, but that it shall have entirely disappeared, else a few belated blossoms will prove fatal in proportion to their increased attractiveness to the bees.

Two pests of the clover field, the Clover Root borer, *Hylesinus trifolii*, and the Clover Leaf weevil, *Phytonomus punctatus*, have attracted some attention in the State, and their distribution in Ohio, as known in 1894, is given in Figs. 6 and 7.

During the year the following species of parasites have been reared, those followed by MS. being as yet undescribed:

Elachistus ohioensis (MS.), Ashmead: Reared from pupæ, in which stage it probably passes the winter; found November 7, within the shells of beech-nuts, the kernels of which had been attacked and eaten by some kind of larva which had burrowed out these kernels, leaving only a mass of excrement. A hole in the shells indicated an attack similar to that of some species of *Balaninus*, though, as I found no larvæ of them, it was impossible to learn their exact nature. Locality, Wooster, Ohio.

Cirrospilus flavicinctus, Riley: This was described in Lintner's First Report as being reared from *Bucculatrix pomifoliella*, Clemens, in Missouri, and also New York. My rearings were from *Aspidisca splendoriferella*, Clem., the cocoons of which were collected near Cleveland, Ohio.

Aphidius chenopodiaphidis (MS.), Ashmead: This was reared from an Aphid found on the leaves of *Chenopodium album*, Linn., collected in the vicinity of Cleveland, Ohio, June 29.

Isocratis vulgaris, Walker: This and an undetermined *Apanteles* were reared with the species next following.

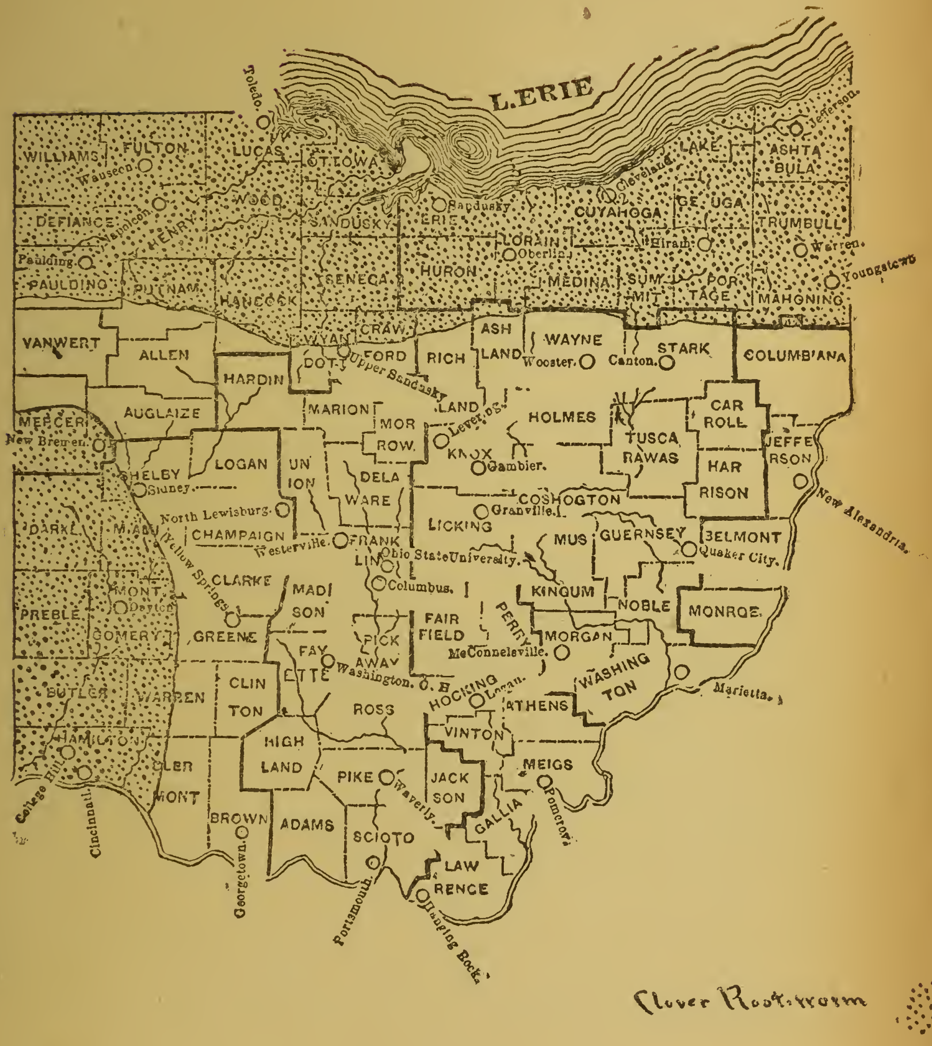
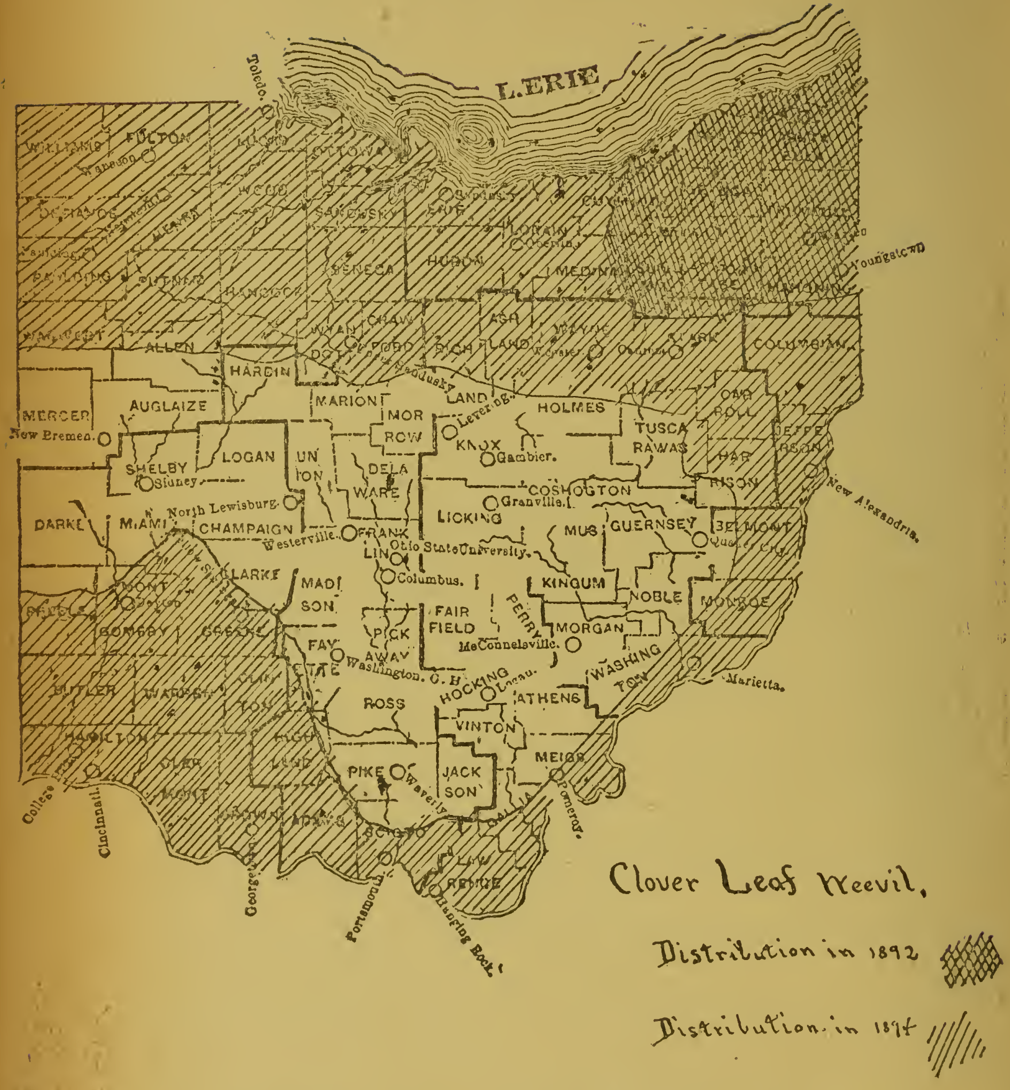


FIG. 6. Showing known distribution of *Hylesinus trifolii*, in Ohio, in 1894.



7. Showing known distribution of *Phytonomus punctatus*, in Ohio, in 1894.

Lysiphlebus salicaphis, Fitch: Reared August 24 from Aphid on Wahoo, *Euonymus atropurpureus*, Jacq., near Wooster, Ohio.

Pachyneuron aphidvora, Ashmead: Reared from Aphid on leaves of *Liriodendron tulipifera*, Linn., collected in Bernett Woods, Cincinnati, Ohio, June 29.

Rhaphitelus maculatus, Walker: This was reared from *Scolytus rugulosus*, Ratz., burrowing in the trunks and larger limbs of fruit trees in Northern Ohio.

Praon coloradensis, Ashmead: Reared from an Aphid on Gladiolus, August 8. Locality, Cleveland, Ohio.

Elasmus nigrescens, Ashmead: Reared from cocoons on leaves received from Warren county, Southern Ohio. The leaves appear to have been attacked by Fall Web worm, though none of these caterpillars were present. Date of emerging, September 17.

Eulophus tricladus, Prov.: Reared from mines of *Tischeria malifoliella*, Clem., in leaves of apple, received from near Schenectady, N. Y.

Segnipiesis nigrifemora, Ashmead: Reared from the same host as the preceding species, and from the same locality, but from another lot of leaves.

Microgaster xylinoides (MS.), Ashmead: Found, dead, in fold of leaf of Linden; Wooster, Ohio, October 15, 1894 The fold had been made by some leaf-folding larva, and extended along one of the lateral veins of the leaf.

Habrocytus aulacis (MS.), Ashmead: Reared from stems of *Lactuca canadensis*, Linn., collected near Lodi, Ohio, October 26, 1894.

Spilochalcis torvina, Cresson: This was reared from the rather conspicuous cocoon, which is dingy-white banded with black. Have collected similar cocoons in Tensas Parish, Louisiana, and also in Indiana. These were from near Cleveland, Ohio.

Rhodites spinosa, Ashmead: (Described only from the galls.) Both sexes were reared from spiny galls on rose, growing along the edges of woods in Huron county, Ohio. Females emerged in the fields on May 11, and the males followed within a few days. Collected and reared May, 1894.

Amblynotus iowensis, Ashmead: This was reared from a mass of grape leaves, affected by Phylloxera and collected along the shore of Lake Erie, near Cleveland, Ohio. From the same leaves a considerable number of *Hemerobius occidentalis*, Fitch, were also reared.

The determinations were made by Mr. W. H. Ashmead.

In conclusion, it may be stated that the Entomologist is ready and more than willing to double his usefulness to the people, but without a proper support, the matter must necessarily end with the willingness.

REPORT OF THE BOTANIST.

Aug. D. Selby.

The present Botanist was appointed in May, but did not enter upon his duties until September first; the period covered by this report is therefore quite short.

The first attention was given to matters of equipment. From the subjects previously studied in this department and from other considerations, perhaps, the facilities for the investigation of fungous and bacterial diseases were limited. Some urgent needs still remain. A set of Saccardo's "Sylloge Fungorum," ten volumes, devoted to the description of practically all known species of fungi, was immediately purchased. The famous German work upon the same subject, Winter's "Die Pilze," was later secured, also the first part or volume of the new edition (second) of Frank's "Krankheiten der Pflanzen," an extremely useful handbook. Some others have been either purchased or ordered, so that occasional additions hereafter, may keep the working library up to requirements. Other matters of equipment remain for future purchase. The Station should certainly look forward to well equipped departments if the best work is to be expected.

Of the conveniences afforded by the present quarters, little need be said, since the housing is only temporary, and has all the usual disadvantages of such location. The rooms for this department, as planned in the proposed office building on the Station grounds, offer every reasonable facility and an additional feature of importance, convenience to the Botanist's green-house. This discussion of facilities may be properly closed by emphasizing the need of better equipment for microscopic work, and of other sets of fungi (exsiccata).

The work which has occupied my time and attention has been of two sorts:

(1.) Work pertaining to weeds.

(2.) Study of fungi and fungous diseases, with rather a large proportion to the matter of weeds.

A Bulletin, No. 55, upon the Russian Thistle and Weeds in General, including Ohio Weed Laws, and an emergency poster supplement to it, devoted to the Russian thistle, were prepared and submitted for publication in October.

The poster was sent to postoffices in the northern and western portions of the State and supplied to railroad authorities for use of section foremen. The aim has been to secure the prompt destruction of the Russian thistle as it appears. If this can be attained, farmers will be saved great expense and inconvenience. The manner of distribution of the seeds of this weed makes it possible to control it, if measures taken are prompt and thorough. In justice to the railroad authorities, it should be stated that they have shown marked interest in these measures for the destruction of the Russian thistle. The valued feature of co-operation with the Station has not been wanting.

Many weeds have been sent for identification; several having mistaken the prickly lettuce and tumbleweed for the Russian thistle. The appended list contains the more important of these weeds. From the list it will be seen that, besides the Russian thistle, other newly introduced plants promise to appear as troublesome weeds. *Thlaspi arvense*, pennycress and *Solanum rostratum*, prickly fruited Solanum, are referred to particularly.

SOME OF THE PLANTS IDENTIFIED.

Common name.	Botanical name.
Agrimony	*Agrimonia striata* Mx.
" small flowered	*Agrimonia parviflora*, D. Ait.
Aster or steel weed[1]	*Aster ericoides pilosus* (Wild Porter) L. & G.
Blue weed[2]	*Echium vulgare* L.
Black nightshade	*Solanum nigrum* L.
Horse nettle[3]	*Solanum carolinense* L.
Moth mullein	*Verbascum blattaria* L.
Narrow leaved plantain	*Plantago lanceolata* L.
Pennycress	*Thlaspi arvense* L.
Prickly fruited solanum[2]	*Solanum rostratum* Dunal.
Prickly lettuce[2]	*Lactuca scariola* L.
Russian thistle	*Salsola kali tragus* (L.) Moq.
Tumbleweed[2]	*Amarantus albus* L.
Velvet weed	*Abutilon abutilon* (L.) Rus.

In fungous diseases a good deal of time has been devoted to a preliminary study of peach troubles. A paper upon this subject was read before the Ohio State Horticultural Society at its December meeting. Some new or unusual peach diseases are under examination. Two raspberry diseases are also being studied. Several specimens of diseased plants have been received and examined. The Maple Rhytisma, *R. acerinum*, appears to be quite frequent on the maple shade trees.

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[1] The aster or steel weed, as it is called, is reported very aggressive in Brown and Clermont counties.

[2] These plants were mistaken for the Russian thistle.

[3] Horse nettle is very troublesome and difficult to control in some localities in Eastern and Southern Ohio.

The work outlined for the next year contemplates the same twofold study of fungous diseases and weed pests; in the former special studies will be made of—

1. Peach diseases, including treatment of leaf curl and twig spot.
2. New raspberry troubles.

In the matter of weeds, continued attention will be devoted to the eradication of the Russian thistle and other new weed pests as these may appear in the State. Constant effort will be given toward securing a better destruction of weeds along highways, railroads and upon private holdings. The time has come when an illustrated account of Ohio weeds should be prepared. While the means of illustrating such a bulletin is not now at the disposal of the Botanist, such material as is available will be collected and illustration carried on whenever the necessary funds may be secured.

Although the diseases of the peach and the raspberry are mentioned as the subject of special investigation, it is understood that whatever fungous or bacterial diseases of cultivated plants may be brought to the notice of the Botanist will receive such attention as their importance warrants and time and means at his disposal may permit.

REPORT OF THE CHEMIST.

AUG. D. SELBY.

Practically no work was done by the undersigned in the chemical laboratory during the year 1894. Some samples of milk were examined and samples of fertilizers and soils were taken for future analysis.

The plans for this department do not include any special investigations of chemical subjects, but rather, for the present, such routine determinations as are required in feeding and fertilizer experiments. This is all that is practicable without help in analytical work. It is not expected to issue any chemical bulletins, but that the results reached shall be published in connection with the department for which the examinations were made.

The present equipment is fairly adequate and will continue so while the laboratory remains in its temporary location.

APPENDIX.

BULLETIN

OF THE

Ohio Agricultural Experiment Station

1894.

CONTENTS.

PAGE

Field Experiments with Commercial Fertilizers, - - - 1

Strawberries: Cultural Notes and Comparison of Varieties, - 35

The Russian Thistle in Ohio and Weeds in General, - - 53

The San José Scale, - - - - - - - - 81

Oats: Comparison Varieties, Cultnral Tests, and Notes on Smut, 97

Meteorological Summary - - - - - - - - 117

Index, - - - - - - - - - - 129

BULLETIN

OF THE

Ohio Agricultural Experiment Station.

NUMBER 53. MARCH, 1894.

FIELD EXPERIMENTS WITH COMMERCIAL AND OTHER FERTILIZERS IN 1893.

[BY C. E. THORNE AND J. FREMONT HICKMAN.]

The general plan of these experiments is as follows:

A tract of uniform land is divided into plots containing one tenth or one-twentieth acre each; the plots are 16 feet wide and are separated by alley-ways 2 feet wide. Under every second alley-way a tile drain is laid. In the case of the wheat plots the soil is clay, lying upon the bowlder clay of the drift, and that upon Huron shale at a depth of 15 to 20 feet. It was formerly covered with forest, in which beech and elm predominated, and was wet and heavy before being drained. The plots on which corn and oats are grown have a gravel sub-soil, which gives partial drainage.

Twenty-two tenth-acre plots are devoted to the continuous culture each of wheat, corn and oats, each plot receiving the same treatment each year. Table 1 gives the order in which the plots are arranged, the quantity and cost per acre of fertilizer applied to each plot, and the quantity per acre of essential ingredients contained. The cost is computed on the basis of the present price per ton in eastern markets, with five dollars per ton added for freight.

TABLE 1.—FERTILIZERS ON WHEAT, CORN AND OATS GROWN CONTINUOUSLY.—Quantity and cost per acre.

Plot No.	Fertilizers.	Quantity.	Essential Ingredients.			Cost.
			Nitrogen.	Phos. acid.	Potash.	
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	
1	Unfertilized	....	....	....	....	....
2	Superphosphate[1]	320		50		4 00
3	Muriate of Potash	80[4]			40[4]	1 75
4	Unfertilized	....	....	....	....	....
5	Nitrate of Soda	160[2]	25[2]			4 25
6	Nitrate of Soda	160[2]	25[2]			8 25
	Superphosphate	320		50		
7	Unfertilized	....	....	....	....	....
8	Superphosphate	320		50		5 75
	Muriate of Potash	80[4]			40[4]	
9	Nitrate of Soda	160[2]	25[2]		40	6 00
	Muriate of Potash	80				
10	Unfertilized	....	....	....	....	....
11	Superphosphate	320		50		
	Muriate of Potash	80[4]			40[4]	10 00
	Nitrate of Soda	320	25[2]			
12	Superphosphate	320		50		
	Muriate of Potash	80			40	14 25
	Nitrate of Soda	320	50			
13	Unfertilized	....	....	....	....	....
14	Superphosphate	320		50		
	Muriate of Potash	80[4]			40[4]	18 50
	Nitrate of Soda	480[3]	75[3]			
15	Superphosphate	320		50		
	Muriate of Potash	80			40	10 25
	Sulphate of Ammonia	120	25			
16	Unfertilized	....	....	....	....	....
17	Dissolved S. C. Rock	320		45		
	Muriate of Potash	80[4]			40[4]	8 55
	Nitrate of Soda	160[2]	25[2]			
18	Basic Slag[5]	300		60		
	Muriate of Potash	80[4]			40	9 45
	Nitrate of Soda	160[2]	25[2]			
19	Unfertilized	....	....	....	....	....
20	Barnyard manure	8 tons.	75	25	50	
21	Linseed oil-meal	1000	50	20	15	13 00
22	Unfertilized	....	....	....	....	....

---

[1] "Superphosphate" in all cases is dissolved bone-black.

[2] 480 and 75 pounds in 1888.

[3] 160 and 25 pounds in 1888.

[4] 160 and 80 pounds previous to 1892.

[5] Also known as "odorless phosphate."

Stated in another form, plots 11, 15, 17 and 18 of this experiment each receive at the rate of 520 to 560 pounds per acre of a fertilizer containing about 5⅓ to 6 per cent. ammonia (ammonia being about 80 per cent. nitrogen), 8 to 9 per cent. available phosphoric acid and 7 to 7¾ per cent. potash. On plot 6 the same quantities of nitrogen and phosphoric acid are used, but by omitting the potash the percentages are changed to the equivalent of 6⅓ per cent. ammonia and 10½ per cent. phosphoric acid.

FERTILIZERS ON WHEAT GROWN CONTINUOUSLY ON THE SAME LAND.

This is the fifth successive crop of wheat grown on these plots. The history of the previous crops is given in Bulletin 49 of this Station.

Immediately after a crop is removed the ground is plowed to the depth of 8 or 9 inches, and it is rolled and harrowed six or seven times between plowing and seeding, the surface being reduced to the condition of a garden and no weeds being allowed to grow.

The fertilizers are spread broadcast, just before drilling the wheat, except the nitrate of soda. This is a coarse, easily soluble salt, and to apply it all in the fall would involve the leaching away of a large part of it before the plant could make use of it.

In 1890 it was all sown in the spring, about the middle of April. For the crop of 1891 the application was divided, half being sown in the fall and half in April. For the crops of 1892 and 1893, dried blood was used in the fall at the rate of forty pounds per acre, and nitrate of soda was sown in April in quantity sufficient to bring the total application up to the desired amount. The sulphate of ammonia is all applied in the fall.

The result of the harvest is given in Tables II, III and IV, together with those of the four preceding harvests, and the average results of the five years' experiments.

[In these and subsequent tables the increase for the fertilized plots has been calculated on the assumption that if the yields of two neighboring unfertilized plots, 1 and 4, for example, were twenty-five and twenty-eight bushels, respectively, the unaided yield of the fertilized plots between, 2 and 3, would have been twenty-six and twenty-seven bushels. The "average yield of unfertilized plots" is given in each table for general comparison, but is not used in calculating the increase.]

TABLE II.—Fertilizers on Wheat Five Years in Succession.

Yield and increase of GRAIN *in bushels per acre.*

Plot No.	Fertilizers.	Yield per acre.						Increase or decrease (—) per acre.						Plot No.
		1889.	1890.	1891.	1892.	1893.	Av.	1889.	1890.	1891.	1892.	1893.	Av.	
1	None	50.5	31.9	31.8	26.2	32.1	34.5	......	......	......	......	......	......	1
2	Superphosphate (dissolved bone-black)	50.2	35.6	29.3	31.2	35.2	36.3	2.9	3.7	—2.6	4.7	5.6	2.9	2
3	Potash (muriate)	47.5	32.1	30.2	28.2	27.7	33.1	3.5	0.3	—1.7	1.3	0.7	0.8	3
4	None	40.8	31.8	32.0	27.2	24.5	31.3	......	......	......	......	......	......	4
5	Nitrate of soda (1)	40.0	36.5	33.7	27.9	31.6	33.9	—3.0	4.3	0.6	0.2	6.3	1.7	5
6	Nitrate and superphosphate (1)	40.8	38.6	31.2	28.9	33.5	34.6	—4.5	6.0	—3.0	0.8	7.4	1.3	6
7	None	47.5	33.0	35.3	28.6	26.8	34.2	......	......	......	......	......	......	7
8	Superphosphate and potash	41.6	36.4	30.5	30.2	36.0	34.9	—4.7	3.6	—3.4	1.7	8.8	1.2	8
9	Nitrate and potash (1)	45.6	36.8	33.4	29.1	35.4	36.1	0.4	4.2	0.8	0.8	7.9	2.8	9
10	None	44.0(3)	32.4	31.2	28.1	27.7	32.7	......	......	......	......	......	......	10
11	Superphosphate, potash and nitrate 160 (1)	49.5	36.9	28.8	29.1	38.6	36.6	5.4	5.3	—2.5	1.4	10.9	4.0	11
12	Superphosphate, potash and nitrate 320	49.3	35.7	29.7	29.2	42.7	37.3	5.2	5.0	—1.7	2.0	15.1	5.1	12
13	None	44.2	29.9	31.5	26.8	27.5	32.0	......	......	......	......	......	......	13
14	Superphosphate, potash and nitrate 480 (2)	47.0	34.9	28.8	29.2	39.7	35.9	4.9	4.2	—2.5	2.1	13.0	4.3	14
15	Superphosphate, potash and ammonia	47.0	33.8	29.8	30.4	34.8	35.2	7.1	2.2	—1.2	3.0	8.8	4.0	15
16	None	37.8	32.4	30.8	27.8	25.2	30.8	......	......	......	......	......	......	16
17	Rock phosphate, potash and nitrate (1)	40.0	37.4	33.2	31.1	32.6	34.9	1.3	5.5	2.2	4.1	8.1	4.2	17
18	Slag phosphate, potash and nitrate (1)	39.3	37.3	31.7	31.6	35.2	35.0	—0.3	5.8	0.4	5.4	11.5	4.6	18
19	None	40.5	31.0	31.5	25.4	22.8	30.0	......	......	......	......	......	......	19
20	Barnyard manure	44.5	34.7	27.3	25.4	37.3	33.8	5.3	5.2	—2.7	1.1	13.8	4.5	20
21	Linseed oil meal	38.7	33.9	34.7	27.5	35.5	34.1	0.7	5.9	6.1	4.2	11.3	5.6	21
22	None	36.7	26.5	27.1	22.2	24.7	27.4	......	......	......	......	......	......	22
	Average of unfertilized plots	42.8	31.1	31.4	26.5	26.4	31.6	......	......	......	......	......	......	
	Average increase from fertilizers	......	......	......	......	......	......	1.7	4.4	—0.8	2.3	9.2	3.3	

(1) 480 pounds nitrate in 1889.
(2) 160 pounds nitrate in 1889.
(3) Estimated.

TABLE III.—FERTILIZERS ON WHEAT FIVE YEARS IN SUCCESSION.

Yield and increase of STRAW *in pounds per acre.*

Plot No.	Fertilizers.	Yield per acre.						Increase or decrease (—) per acre.						Plot No.
		(3) 1889.	1890.	1891.	1892.	1893.	Average.	1889.	1890.	1891.	1892.	1893.	Average.	
1	None	4,070	3,602	4,540	3,015	2,495	3,544	....	....	....	....	....	....	1
2	Superphosphate (dissolved bone-black)	4,208	3,885	4,995	4,265	3,270	4,125	264	390	642	1,372	1,120	757	2
3	Potash (muriate)	3,850	3,062	3,740	3,190	2,175	3,203	32	—327	—427	418	355	10	3
4	None	3,692	3,282	3,980	2,650	1,490	3,019	....	....	....	....	....	....	4
5	Nitrate of soda (1)	3,560	3,930	3,980	2,710	2,705	3,377	—251	630	— 83	— 13	995	256	5
6	Nitrate and superphosphate (1)	3,512	4,385	5,330	3,830	2 690	3,949	—419	1,064	1,183	1,033	800	732	6
7	None	4,050	3,340	4,230	2,870	2,090	3,316	....	....	....	....	....	....	7
8	Superphosphate and potash	3,304	4,152	4,570	3,625	3,444	3,819	—563	703	557	778	1,372	570	8
9	Nitrate and potash (1)	4,504	3,852	4,395	2,990	2,975	3,743	821	294	598	167	922	560	9
10	None	3,500	3,667	3,580	2,800	2,035	3,116	....	....	....	....	....	....	10
11	Superphosphate, potash and nitrate 160 (1)	4,270	4,725	5,675	4,390	3,985	4,609	754	1,250	2,047	1,58[illegible]	1,912	1,509	11
12	Superphosphate, potash and nitrate 320	4,262	4,835	5,965	4,360	3,540	4,592	730	1,551	2,298	1,543	1,428	1,510	12
13	None	3,548	3,092	3,710	2,825	2,150	3,065	....	....	....	....	....	....	13
14	Superphosphate, potash and nitrate 480 (2)	3,920	4,592	5,820	4,235	3,515	4,416	344	1,428	2,280	1,447	1,553	1,410	14
15	Superphosphate, potash and ammonia	3,920	3,720	4,660	3,860	3,310	3,894	316	485	1,290	1,108	1,537	947	15
16	None	3,632	3,307	3,200	2,715	1,585	2,888	....	....	....	....	....	....	16
17	Rock phosphate, potash and nitrate (1)	3,460	4,175	4,860	3,720	2,845	3,812	—153	987	1,607	1,090	1,192	945	17
18	Slag phosphate, potash and nitrate (1)	3,542	4,312	4,800	3,870	2,790	3,863	— 49	1,243	1,493	1,325	1,082	1,017	18
19	None	3,570	2,950	3,360	2,460	1,790	2,826	....	....	....	....	....	....	19
20	Barnyard manure	4,030	3,850	4,810	3,110	3,490	3,858	770	991	1,645	787	1,648	1,168	20
21	Linseed oil-meal	3,618	3,775	4,670	2,835	3,154	3,610	668	1,007	1,700	648	1,234	1,051	21
22	None	2,640	2,677	2,775	2,050	1,985	2,425	....	....	....	....	....	....	22
	Average of unfertilized plots	3,588	3,240	3,672	2,673	1,951	3,025	....	....	....	....	....	....	
	Average increase from fertilizers	....	....	....	....	....	....	233	835	1 202	949	1,225	889	

(1) 480 pounds nitrate in 1889. (2) 160 in 1889.

(3) Corrected weight. The weights reported for "straw" in the bulletin for 1890, page 52, include total produce.

RATIO OF STRAW TO GRAIN.

Table IV shows the number of pounds of straw required to carry a bushel of grain on each plot of the wheat in continuous culture for each year of the test and for the five-year average:

TABLE IV.—FERTILIZERS ON WHEAT, FIVE YEARS IN SUCCESSION.

Pounds of STRAW *to one bushel of grain.*

Plot No.	Fertilizers.	Straw to bushel.						Plot No.
		1889.	1890.	1891.	1892.	1893.	Av.	
1	None	80	113	140	115	78	105	1
2	Superphosphate (dissolved bone-black)	82	109	170	137	93	118	2
3	Potash (muriate)	80	95	124	113	78	98	3
4	None	90	103	124	98	61	95	4
5	Nitrate of soda (¹)	89	108	118	97	86	100	5
6	Nitrate and superphosphate (¹)	86	113	171	132	80	116	6
7	None	85	101	120	100	78	97	7
8	Superphosphate and potash	80	114	150	120	93	111	8
9	Nitrate and potash (¹)	99	105	132	103	84	105	9
10	None	80	113	114	100	73	96	10
11	Superphosphate, potash and nitrate, 160 (²)	86	128	197	151	103	133	11
12	Superphosphate, potash and nitrate, 320	86	135	192	149	83	129	12
13	None	80	104	118	106	78	97	13
14	Superphosphate, potash and nitrate, 480 (¹)	83	131	202	145	88	130	14
15	Superphosphate, potash and ammonia	83	110	156	127	95	114	15
16	None	96	102	104	97	63	92	16
17	Rock phosphate, potash and nitrate (¹)	86	112	146	119	87	110	17
18	Slag phosphate, potash and nitrate (¹)	90	116	151	122	79	112	18
19	None	88	95	107	97	78	93	19
20	Barnyard manure	90	111	176	122	94	99	20
21	Linseed oil-meal	93	111	134	103	89	106	21
22	None	72	101	102	90	80	89	22
	Average of unfertilized plots	84	104	116	100	74	95	

(¹) 480 pounds nitrate in 1889.
(²) 160 pounds nitrate in 1889.

The crop of 1893 has shown a larger increase from the fertilizers than any other crop of the series. In one case (plot 12) the yield practically reaches the average unfertilized yield on clover sod in 1889, the increase amounting to fifteen bushels per acre. This increase, however, was produced at a cost of $14.25 in fertilizers.

On the plot fertilized with barnyard manure the increase this year gives nearly fourteen bushels of wheat for eight tons of manure, or a bushel and three-fourths of wheat to the ton of manure.

In the five-year average, however, the increase from manure has been but little more than half a bushel to the ton, and in the most favorable outcome it has been less than three-fourths of a bushel to the dollar's worth of chemical fertilizers.

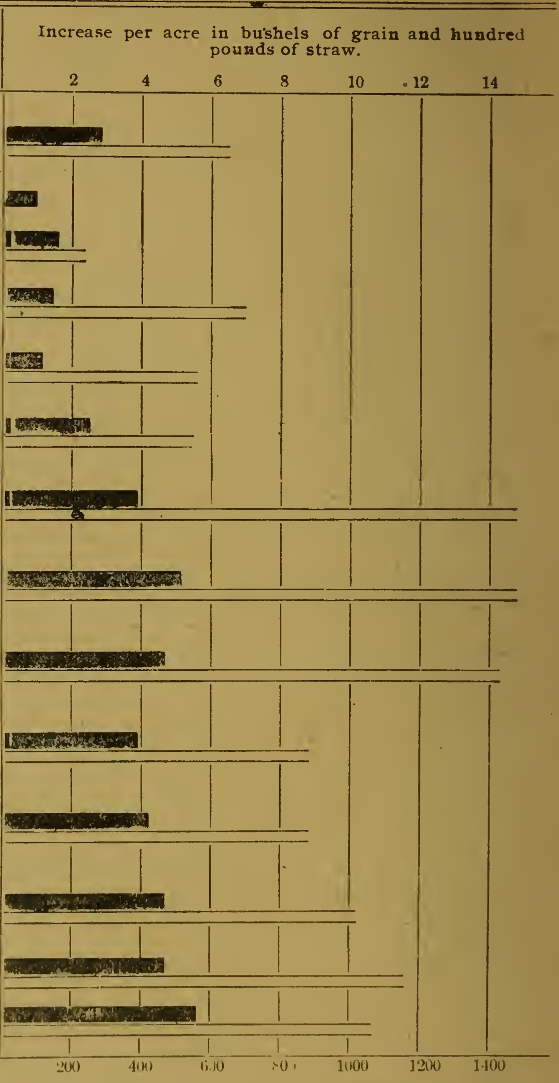
In the following diagram is shown the relative increase of grain and straw for the five years, the increase of grain being shown in shaded lines, that of straw in open lines. Table IV shows that in the general average it has required ninety-five pounds of straw to carry a bushel of grain on the unfertilized plots. Had the fertilized plots carried grain in the proportion of one bushel to 100 pounds of straw the lines showing increase of grain would have coincided with those showing increase of straw, giving a very different result from that actually obtained.

FERTILIZERS ON WHEAT IN CONTINUOUS CULTURE.

Average annual increase per acre for five years.

Grain ▬; Straw ═.

Plot.	Fertilizers per acre.	Lbs.
2	Superphosphate (Dissolved bone-black).	320
3	Muriate of potash	80
5	Nitrate of soda	160
6	Nitrate of soda Superphosphate	160 320
8	Superphosphate Muriate of potash	320 80
9	Nitrate of soda Muriate of potash	160 80
11	Superphosphate Muriate of potash Nitrate of soda	320 80 160
12	Superphosphate Muriate of potash Nitrate of soda	320 80 320
14	Superphosphate Muriate of potash Nitrate of soda	320 80 480
15	Superphosphate Muriate of potash Sulphate of ammonia	320 80 120
17	Rock phosphate Muriate of potash Nitrate of soda	320 80 160
18	Basic slag Muriate of potash Nitrate of soda	300 80 160
20	Barnyard manure	16,000
21	Linseed oil-meal	1,000



Attention is called to the effect of the different fertilizing constituents, as graphically shown in this diagram, and especially as manifested in the increase of straw. The great increase of straw following the use of phosphoric acid in any form, and especially in the form of bone-black superphosphate, is most conspicuous, as well as the fact that while nitrogen and potash, used without phosphoric acid, have produced comparatively little increase, yet when both nitrate of soda and muriate of potash have been added to superphosphate they have more than doubled the yield of straw over that given by superphosphate alone, or superphosphate in combination with either the nitrate or muriate, but not with both.

Apparently the rock superphosphate and the basic slag are producing quite as large an increase of grain as the bone superphosphate, although the increase of straw is considerably smaller.

COST AND VALUE OF INCREASE.

During the five years over which this experiment has now extended the cash price of No. 2 spring wheat (the standard grade) has averaged 83½ cents in Chicago, as reported by the *Cincinnati Price Current*. This would represent an average value in Ohio not exceeding 80 cents.

Table V. shows the financial outcome of this attempt at maintaining fertility by the use of chemical fertilizers; the cost of fertilizers being estimated at the present retail cost of fertilizing chemicals in Ohio (which is considerably less than the average cost of the ordinary mixed fertilizers of equal quality, as sold to the farmers) and the value of the product being based upon 80 cents per bushel for wheat and $3.00 per ton for straw. Barnyard manure is valued at 50 cents per ton, a price which will considerably more than cover the cost of getting it from the barnyard to the field on the ordinary farm; but if the manure is purchased in town and hauled several miles its cost may equal that of the chemical fertilizers.

TABLE V.—FERTILIZERS ON WHEAT IN CONTINUOUS CULTURE.

Average value of increase and cost of fertilizers for five years.

Values per acre per annum.

Plot No.	Value of increase.			Cost of fertilizer.	Profit (+) or loss (—).
	Grain.	Straw.	Total.		
2	$2.32	$1.13	$3.45	$4.00	$—0.55
3	0.64	0.01	0.65	1.75	—1.10
5	1.36	0.38	1.64	4.25	—2.61
6	1.04	1.10	2.14	8.25	—6.11
8	0.96	0.85	1.81	5.75	—3.94
9	2.24	0.84	3.08	6.00	—2.92
11	3.20	2.26	5.46	10.00	—4.54
12	4.08	2.26	6.34	14.25	—7.91
14	3.44	2.11	5.55	18.50	—12.95
15	3.20	1.42	4.62	10.25	—5.63
17	3.36	1.42	4.78	8.55	—3.77
18	3.68	1.52	5.20	9.45	—4.25
20	3.60	1.75	5.35	4.00	+1.35
21	4.48	1.58	6.06	13.00	—6.94

It should be distinctly understood that the problem in this case is not the restoring of fertility to a worn out soil, but it is one of not less importance, namely: the maintenance in productiveness of an already fertile soil. Of course, no intelligent farmer would attempt to solve this problem by the continuous culture of wheat manured only with chemicals; but it is only by this method that the actual capacity of the plant for securing its sustenance can be determined. This experiment shows that a method which would at once be condemned as irrational, from the farmer's standpoint, may yet be followed with profit when barnyard manure is substituted for chemicals.

FERTILIZERS ON OATS GROWN CONTINUOUSLY ON THE SAME LAND.

In Tables VI and VII are given the yield and increase of grain and straw for five years in the experiments with oats. It will be observed that each of the three fertilizing substances has apparently produced about the same increase of crop, and that no combination of these substances has added materially to the yield which followed their separate use. The explanation of this is partly to be found in the fact that the oat plant does not find in the climate of southern Ohio the conditions suited to its normal development. It will be noticed that not one of the five crops under review has given what would be called a good yield.

TABLE VI.—FERTILIZERS ON OATS, FIVE YEARS IN SUCCESSION.

Yield and increase of GRAIN *in bushels of 32 pounds.*

Plot No.	Fertilizers.	Yield per acre.						Increase or decrease (—) per acre.						Plot No.
		1889.	1890.	1891.	1892.	1893.	Average.	1889.	1890.	1891.	1892.	1893.	Average.	
1	None	44.2	16.0	[2]										1
2	Superphosphate (dissolved bone black)	46.9	19.4	46.6	29.4	[4]		1.4	3.4	6.4	0.6			2
3	Potash (muriate)	59.5	19.7	45.9	32.5	33.9	38.3	12 6	3.7	5.7	3.7	4.1	5.9	3
4	None	48.2	16.0	40.2	28.8	29.8	32.6							4
5	Nitrate of soda	47.2	21.1	45.6	32.7	39.2	37.2	0.1	3.9	5.3	5.4	8.4	4.6	5
6	Nitrate and superphosphate	48.4	22.3	51.2	32.2	37.6	38.3	2.3	3.8	10.7	6.4	5.7	5.8	6
7	None	45.0	19.7	40.6	24.3	32.9	32.5							7
8	Superphosphate and potash	45.0	21.6	46.6	32.2	32.7	35.6	—0 8	2.3	4.3	4.5	—1.3	1.8	8
9	Nitrate and potash	48.4	23.7	46.6	40 3	38.6	39.5	1.8	4.9	2.7	9.3	3.6	4.4	9
10	None	47.5	18.4	45.6	34.4	36.1	36.5							10
11	Superphosphate, potash and nitrate, 160	52.9	24.7	50.9	40.9	43.9	42.7	5.6	7.4	6.0	3.6	5.3	5.6	11
12	Superphosphate, potash and nitrate, 320	47.8	25.3	52.3	43.1	44.5	42.6	0.8	9.0	8.2	3.0	3.4	4.9	12
13	None	46.8	15.2	43.4	43.0	43.6	38.5							13
14	Superphosphate, potash and nitrate, 480[1]	45.0	20.8	48.4	43.3	46.2	40.7	1.6	4.3	3.9	2.1	6.5	3.6	14
15	Superphosphate, potash and ammonia	51.8	23.9	49.4	40.1	38.7	40.8	11.9	6.0	3.9	0.8	2.8	5.1	15
16	None	36.5	19.2	46.6	37.5	32.0	34.4							16
17	Rock phosphate, potash and nitrate	47.3	21.6	49.7	41.1	44.7	40.9	10.3	4.0	3.7	4.0	12.7	6.9	17
18	Slag phosphate, potash and nitrate	45.7	22.8	51.6	43.6	[4]		8.4	6.7	6.3	6.8			18
19	None	37.9	14.5	44.7	36.4	[4]								19
20	Barnyard manure	42.8	19.1	50.3	36.9	30.8	36.0	2.2	3.3	5.6	0.5	2.7	2.9	20
21	Linseed oil meal	50.6	14.8	46.7	25.8	33.3	34.2	7.2	—2.3	2.0	—10.6	5.2	0.3	21
22	None	46.1	18.4	[4]	[3]	28.1								22
	Average of unfertilized plots	44.0	17.2	43.5	34.1	33.7	35.1							
	Average increase from fertilizers							4.7	4.5	5.3	2.9	4.9	4.4	

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[1] Dried blood, 160 pounds, instead of nitrate in 1892. [2] This plot cut into by opening of street. [3] Injured by grasshoppers. [4] Record lost.

TABLE VII.—FERTILIZERS ON OATS, FIVE YEARS IN SUCCESSION.

Yield and increase of STRAW *in pounds per acre.*

Plot No.	Fertilizers.	Yield.						Increase or decrease (—).						Plot No.
		1889.	1890.	1891.	1892.	1893.	Average.	1889.	1890.	1891.	1892.	1893.	Average.	
1	None	3,180	1,900	(²)......	....	(³)......	....	....	....	....	....	....	....	1
2	Superphosphate	3,520	2,370	3,310	2,960	....	....	133	343	845	180	....	....	2
3	Muriate potash	4,220	2,270	2,680	3,100	1,365	2,727	627	317	215	380	240	300	3
4	None	3,800	1,980	2,465	2,780	1,125	2,430	....	....	....	....	....	....	4
5	Nitrate soda	3,980	2,680	2,540	3,155	1,395	2 750	233	653	100	478	263	345	5
6	Superphosphate and nitrate	4,068	2,900	2,160	3,020	1,405	2,711	375	827	—260	445	267	331	6
7	None	3,640	2,120	2,400	2,472	1,145	2,356	....	....	....	....	....	....	7
8	Superphosphate and potash	3,660	2,580	2,910	3,170	1,205	2,705	—87	300	430	541	77	251	8
9	Potash and nitrate	4,040	3,070	2,810	2,960	1,395	2,855	197	630	250	169	283	305	9
10	None	3,960	2,600	2,640	2,950	1,095	2,649	....	....	....	....	....	....	10
11	Superphosphate, potash and nitrate, 160	4,400	3,210	2,620	2,940	1,575	2,949	487	587	5	—68	393	281	11
12	Superphosphate, potash and nitrate, 320	4,300	3,320	2,875	3,020	1,875	3,078	433	673	290	—47	607	391	12
13	None	3,820	2,670	2,560	3 125	1,355	2,706	....	....	....	....	....	....	13
14	Superphosphate, potash and nitrate, 480 (¹)	3,880	2,930	2,550	3,665	1,752	2,956	267	450	57	732	450	391	14
15	Superphosphate, potash and ammonia	4,060	3,270	2,670	2,965	1,370	2,867	653	980	243	223	122	444	15
16	None	3,200	2,100	2,360	2,550	1,195	2,281	....	....	....	....	....	....	16
17	Rock phosphate, potash and nitrate	3,800	2,910	2,110	3,435	1,455	2,740	647	860	—120	640	260	457	17
18	Slag phosphate, potash and nitrate	3.500	3,120	2,200	3,205	(³)......	....	363	1,120	100	165	....	....	18
19	None	3,060	1,950	1,970	3,285	(³)......	....	....	....	....	....	....	....	19
20	Barnyard manure	3,140	2,650	2,540	3,420	1,615	2,673	—167	450	570	143	450	290	20
21	Linseed oil meal	4,100	2,470	2,215	3,675	1,935	2,879	547	20	245	407	770	400	21
22	None	3,800	2,700	(³)......	3,260	1,080	....	....	....	....	....	....	....	22
	Average of unfertilized plots	3,557	2,252	2,400	2,917	1,166	2,484	....	....	....	....	....	....	
	Average increase from fertilizers	....	....	....	....	....	....	338	586	212	313	350	350	

(¹) Dried blood, 160 lbs. instead of nitrate, in 1892 and 1893. (²) Plot cut into by opening of street. (³) Record lost.

FERTILIZERS ON CORN GROWN CONTINUOUSLY ON THE SAME LAND.

Table VIII gives the yield and increase of grain and stalks for 1893 and the average of the six years during which corn has been grown continuously (the experiments with corn beginning with 1888). The yields of grain are reported in bushels of seventy pounds of ears, and by "stalks" is meant stalks and leaves, the corn being cut about four inches from the ground.

TABLE VIII.—FERTILIZERS ON CORN SIX YEARS IN SUCCESSION.

Yield and increase per acre.

Plot No.	Fertilizer.	Yield per acre.				Inc. or dec. (—) per acre.				Plot No.
		Grain.		Stalks.		Grain.		Stalks.		
		1893.	Av. 6 yrs.	1893.	Av. 6 yrs.	1893.	Av. 6 yrs.	1893.	Av. 6 yrs	
		Bu.	*Bu.*	*Lbs.*	*Lbs.*	*Bu.*	*Bu.*	*Lbs.*	*Lbs.*	
1	None	35.6	60.0	2,050	3,769	....	....	....	....	1
2	Superphosphate (dissolved bone black)	38.3	59.7	2,225	3,520	1.9	—1.1	117	—218	2
3	Potash (muriate)	40.7	61.3	2,530	4,120	3.3	—0.3	363	413	3
4	None	38.2	62.3	2,225	3,676	....	....	....	....	4
5	Nitrate of soda	37.6	65 0	2,475	4,443	—0.2	3.7	250	742	5
6	Nitrate and superphosphate	38.9	66.4	2,550	4,294	1 4	6.0	325	568	6
7	None	37.0	59.4	2,225	3,751	....	....	....	....	7
8	Superphosphate and potash	40.0	61.6	2,550	4,067	2 6	1.8	320	298	8
9	Nitrate and potash	40.7	66.6	2,610	4,464	2.8	6.3	375	678	9
10	None	38.3	60.7	2,240	3,804	....	....	....	....	10
11	Superphosphate, potash and nitrate 160	41.2	65.7	2,750	4,216	1.6	4.3	490	383	11
12	Superphosphate, potash and nitrate, 320	40.2	66.8	2,900	4,298	—0.8	4.7	620	441	12
13	None	42.4	62.8	2,300	3,883	....	....	....	....	13
14	Superphosphate, potash and nitrate, 480	40.2	64.9	2,800	4,355	—0.4	4.3	583	707	14
15	Superphosphate, potash and ammonia	42.0	61.4	2,500	4,274	3.2	3.1	367	821	15
16	None	37.0	56.1	2,050	3,177	....	....	....	....	16
17	Rock phosphate, potash and nitrate	40.4	63.0	2,275	4 105	2.8	7.3	317	867	17
18	Slag phosphate, potash and nitrate	38.2	62.4	2,525	3,985	0	7.2	658	688	18
19	None	38.7	55.0	1,775	3,359	....	....	....	....	19
20	Barnyard manure	39.8	63.0	2,425	3,737	0.1	5.2	550	322	20
21	Linseed oil meal	42 4	68.4	2,425	4,320	1.7	7.6	450	850	21
22	None	41.7	63.7	2,075	3,526	....	....	....	....	22
	Average of unfertilized plots	38.6	60.0	2,117	3,618	....	....	....	....	
	Average increase from fertilizers	....	....	....	....	1 2	3.8	361	472	

A striking feature of this test is the small increase of crop from the fertilizers in 1893, the sixth year of successive cropping. This is partly explained by the generally low yield, due to the severe drouth of the summer.

In the six-year average the corn on this land has apparently received no benefit from phosphoric acid or potash, used separately or in combination with each other only; but when nitrogen has been added a decided though small increase of crop is shown in every case. The increase in corn has not been so regular as that in wheat, but it will be observed that the general average increase in the three crops, corn, wheat and oats, is approximately the same—about four bushels per acre.

FERTILIZERS ON CROPS GROWN IN ROTATION.

Parallel with the experiments in continuous cropping, an experiment has been conducted on the Columbus farm in which corn, oats and wheat are grown in rotation with clover and timothy. In this experiment five blocks of land, each containing seven plots of one-twentieth acre each, are cultivated in these crops, the cropping being so managed that each crop is represented each year.

Following is the plan of fertilizing each block:

Plot 1. Unfertilized.

Plot 2. Superphosphate, 300 pounds per acre; muriate of potash, 80 pounds per acre,* on corn only.

Plot 3. Superphosphate, 300 pounds per acre; muriate of potash, 80 pounds per acre,* on wheat only.

Plot 4. Unfertilized.

Plot 5. Superphosphate, 300 pounds per acre; muriate of potash, 80 pounds per acre;* nitrate of soda, 160 pounds per acre, on wheat only.

Plot 6. Barnyard manure, 8 tons per acre, on wheat only.

Plot 7. Unfertilized.

*160 pounds, previous to 1892.

In 1889 and 1890 the crops in this rotation were not grown under such conditions as would make them fairly comparable with the continuous cropping. In 1891 and subsequently, however, the crops grown in rotation have received the same treatment, with respect to preparation of soil, seeding, variety used, etc., as that given the crops in continuous culture. Tables IX and X give the results for wheat of the harvests of 1891, 1892 and 1893, with the average for the three years:

TABLE IX.—Wheat Grown in Rotation.

Yield and increase of GRAIN *per acre.*

Yield per acre.							Increase or decrease (—) per acre.			
1891.		1892.		1893.		Average.	1891.	1892.	1893.	Average.
Plot	*Bushels.*	*Plot*	*Bushels.*	*Plot*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
25	36.7	1	34.2	8	35.2	35.4	....	....	....	....
26	37.8	2	32.4	9	37.0	35.7	0.2	0.1	1.0	0.4
27	36.2	3	35.7	10	41.2	37.7	—2.4	5.4	4.4	2.4
28	39.5	4	28.4	11	37.6	35.2	....	....	....	....
29	36.3	5	35.6	12	43.1	38.3	—1.8	6.7	7.6	4.2
30	38.0	6	28.4	13	36.9	34.4	1.2	—0.9	1.5	0.6
31	35.5	7	29.7	14	34.2	33.1	....	....	....	....
*	37.2		30.8		35.7	34.6				

* Average of unfertilized plots.

TABLE X.—Wheat Grown in Rotation.

Yield and increase of STRAW *per acre.*

Yield per acre.							Increase or decrease (—) per acre.			
1891.		1892.		1893.		Average.	1891.	1892	1893.	Average.
Plot	*Pounds.*	*Plot*	*Pounds.*	*Plot*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
25	4,800	1	3,530	8	3,285	3,872	....	....	....	....
26	3,730	2	3,040	9	3,380	3,383	—913	—220	48	—362
27	5,830	3	3,440	10	3,950	4,407	1,343	477	572	797
28	4,330	4	2,680	11	3,425	3,478	....	....	....	....
29	6,120	5	3,550	12	4,075	4,582	1,877	923	723	1,174
30	4,520	6	2,980	13	3,385	3,628	363	487	107	292
31	4,070	7	2,520	14	3,205	3,265	....	....	....	....
*	4,400		2,910		3,305	3,538				

* Average of unfertilized plots.

Comparing the average yields of the plots similarly treated in the continuous and rotative cropping, we have the results given in Table XI:

TABLE XI.—CONTINUOUS, COMPARED WITH ROTATIVE CROPPING OF WHEAT.

Fertilizer.	Culture.	Yield of grain per acre.			
		1891.	1892.	1893.	Average.
		Bus.	*Bus.*	*Bus.*	*Bus.*
None	Continuous	31.4	26.5	26.4	28.1
	Rotative	37.2	30.8	35.7	34.6
Superphosphate	Continuous[1]	30.5	30.2	36.0	32.2
	Rotative	36.2	35.7	41.2	37.7
Superphosphate, potash and nitrate	Continuous[2]	28.8	29.1	38.6	32.2
	Rotative	36.3	35.6	43.1	38.3
Barnyard manure	Continuous[3]	27.3	25.4	37.3	30.0
	Rotative	38.0	28.4	36.9	34.4
Average	Continuous	29.5	27.8	34.6	30.6
	Rotative	36.9	32.6	39.2	36.2
Average increase for rotation		7.4	4.8	4.6	5.6

[1] Plot 8; [2] Plot 11; [3] Plot 20, in continuous cropping.

It will be observed that not only in the general average, but in every single instance except that of the plots dressed with barnyard manure in 1893, the plots upon which wheat is grown in rotation have exceeded in yield the similarly treated plots upon which it is grown continuously.

Table XII shows the ratio of straw to grain in the rotative cropping and for the plots similarly treated in continuous cropping:

TABLE XII.—ROTATIVE, COMPARED WITH CONTINUOUS, CROPPING OF WHEAT.

Pounds of STRAW *to one bushel of grain.*

Rotative.					Continuous.				
Plot.	1891.	1892.	1893.	Average.	Plot.	1891.	1892.	1893.	Average.
1	133	103	93	109	....	....	....	....	....
2	99	94	91	95	....	....	....	....	....
3	161	96	96	117	8	150	120	93	121
4	110	94	91	98	....	....	....	....	....
5	169	99	94	119	11	197	151	103	150
6	119	105	91	105	20	176	122	94	131
7	115	85	94	99	....	....	....	....	....
Av. unfertilized.	119	94	93	102	....	116	100	74	97

This table shows that wherever fertilizers or manure was used more straw has been required to carry a bushel of grain in continuous than in rotative cropping. In 1891 and 1892 the wheat lodged badly on several of the plots in continuous culture; but there was little or no lodging on the similarly fertilized plots in rotation.

FERTILIZERS ON OATS GROWN IN ROTATION.

The experiments on oats grown in rotation have been still less satisfactory than those on oats grown continuously, only one crop having thus far been brought into the full plan of fertilization. The results of the three harvests, 1891, 1892 and 1893 are given in Tables XIII and XIV. In 1891 none of the plots had been fertilized, but the yield is given for comparison with the yields of the unfertilized plots in continuous cropping. In 1892 the plots had all been fertilized according to plan. In 1893 only the second plot had been fertilized; and the yields of the last three plots are omitted because of discrepancies.

Apparently, the application of phosphoric acid and potash to oats, either directly or to the preceding crop of corn, is of considerable advantage, while the use of nitrogenous manures has been of doubtful benefit; but it is evidently unsafe to draw any general conclusions as yet from these experiments.

The variety of oats called Japan has been used in these tests in 1891 and subsequently, both in the continuous and rotative cropping.

TABLE XIII.—OATS GROWN IN ROTATION.

Yield and increase of GRAIN *in bushels per acre.*

Rotative cropping.								Continuous cropping.		
Yield per acre.						Increase or decrease (—) per acre.		Yield per acre.		
1891.		1892.		1893.		1892.	1893.	1891.	1892.	1893.
1	46.8	8	29.2	15	29.8	....	....	....	....	....
2	46.8	9	37.3	16	37.0	6.7	5.8	46.6	32.2	32.7
3	46.2	10	33.0	17	27.6	1.1	....	....	....	....
4	45.6	11	33.3	18	33.9	....	....	....	....	....
5	45.0	12	35.8	19	....	3.1	....	....	40.9	....
6	43.7	13	27.7	20	....	—4.3	....	....	36.9	....
7	41.8	14	31.4	21	....	....	....	....	....	....
*	44.7		31.3		30.4	....	....	43.5	34.1	33.7

* Average unfertilized.

TABLE XIV.—OATS GROWN IN ROTATION.

Yield and increase of STRAW *in pounds per acre.*

Rotative cropping.										
Yield per acre.						Increase or decrease (—) per acre.		Straw to 1 bushel grain.		
1891.		1892.		1893.		1892.	1893.	1891.	1892.	1893.
1	2,700	8	3,665	15	1,745	....	....	58	125	58
2	2,400	9	4,205	16	2,015	583	327	51	113	54
3	2,320	10	3,945	17	1,415	368	....	50	120	51
4	2,740	11	3,535	18	1,575	....	....	60	106	46
5	2,460	12	4,855	19	....	1,500	....	55	107	....
6	2,300	13	2,915	20	....	—260	....	53	105	....
7	2,660	14	2,995	21	....	....	....	64	95	....
*	2,700		3,398		1,660	....	....	61	109	52

* Average unfertilized.

FERTILIZERS ON CORN GROWN IN ROTATION.

In the rotation experiments no corn has yet come fully under the plan of the experiment, because of the irregularities in cropping incident to getting the rotation regularly started. The crop of 1890 followed oats, and received the application of superphosphate and muriate of potash on the second plot; the crop of 1891 followed wheat, and both the wheat and the corn were fertilized according to plan, but there was no intervening crop of clover and timothy; the crop of 1892 followed clover and received phosphoric acid and potash as planned, but the preceding wheat crop was not fertilized; the crop of 1893 followed two crops of clover and timothy, and received phosphoric acid and potash as planned, but the wheat crop was not fertilized. Tables XV and XVI give the yields of these crops:

TABLE XV.—FERTILIZERS ON CORN IN ROTATION.

Yield and increase of GRAIN *in bushels of 70 lbs. ears.*

Yield per acre.								Increase or decrease (—) per acre.			
1890.		1891.		1892.		1893.		1890.	1891.	1892.	1893.
Plot.	*Bu.*	*Plot.*	*Bu.*	*Plot.*	*Bu.*	*Plot.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*	*Bu.*
1	44.0	8	55.0	15	67.4	32	37.9	....	....	....	....
2	43.8	9	66.4	16	70.6	33	41.0	—0.7	7.7	1.9	0.9
3	46.9	10	71.8	17	72.0	34	40.5	....	9.2	....	....
4	45.4	11	66.4	18	71.1	35	44.4	....	....	....	....
5	41.1	12	71.6	19	63.1	36	43.4	....	5.3	....	....
6	41.7	13	74.1	20	70.9	37	44.4	....	8.1	....	....
7	44.7	14	65.8	21	66.9	38	37.2	....	....	....	....
*	44.7	....	62.4	....	68.5	....	39.9	....	....	....	....
**	46.6	....	57.3	....	65.4	....	38.6	....	....	....	....

*Average unfertilized. **Average of unfertilized crops in continuous culture, for comparison.

TABLE XVI.—FERTILIZERS ON CORN IN ROTATION.

Yield and increase of STALKS *in pounds per acre.*

Yield per acre.								Increase or decrease (—) per acre.			
1890.		1891.		1892.		1893.		1890.	1891.	1892.	1893.
Plot.	*Lbs.*	*Plot.*	*Lbs.*	*Plot.*	*Lbs.*	*Plot.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1	2,411	8	2,680	15	3,600	32	2,300	....	....	....	....
2	2,090	9	3,280	16	4,100	33	2,700	—117	467	560	366
3	2,039	10	3,540	17	3,500	34	2,800	....	593	....	....
4	1,800	11	3,080	18	3,420	35	2,400	....	....	....	....
5	1,964	12	3,540	19	2,800	36	2,800	....	553	....	....
6	1,708	13	3,080	20	3,100	37	2,200	....	207	....	....
7	1,646	14	2,800	21	2,800	38	2,000	....	....	....	....
*	1,952	....	2,853	....	3,273	....	2,233	....	....	....	....
**	2,478	....	3,333	....	3,720	....	2,117	....	....	....	....

*Average unfertilized. **Average of unfertilized crops in continuous culture, for comparison.

In 1891 the corn seems to have been benefited by the residue of fertilizers applied to the preceding wheat crop; but with this exception, the fertilizers have had practically no effect. It appears that the yield of grain on the unfertilized plots has been slightly greater from the corn in rotation than from that in continuous culture (except in 1890), while the reverse has been the case, except in 1893, with regard to the stalks.

CLOVER AND TIMOTHY AFTER FERTILIZERS.

Only one hay crop has thus far come under the complete plan of fertilizing, namely: the first crop of 1893. The first crop of 1892 and the second crop of 1893 have received the benefit of the fertilizers applied to wheat, but not of those designed for corn. In Table XVII are given the yields of all the hay crops harvested.

TABLE XVII.—CLOVER AND TIMOTHY AFTER FERTILIZERS.

Yield of HAY *in pounds per acre.*

1891.		1892.				1893.				Average for fertilized crops.	Increase.
1st crop.[1]		1st crop.[2]		2d crop.[1]		1st crop.[3]		2d crop.			
Plot.	*Lbs.*	*Plot.*	*Lbs.*	*Plot*	*Lbs.*	*Plot.*	*Lbs.*	*Plot.*	*Lbs*		
32	3,270	25	4,600	32	6.120	1	4,040	25	[4]........	4,320	....
33	2,850	26	5.000	33	5,400	2	6,100	26	[4]........	6,100	1,673
34	3,650	27	5,000	34	5,800	3	6,360	27	4,000	5,120	475
35	3,400	28	4.920	35	5,280	4	5,200	28	4,300	4,807	....
36	3,200	29	5,200	36	5,720	5	5,100	29	4.300	4,867	276
37	3,100	30	5,120	37	5,400	6	5,300	30	3,900	4,773	397
38	2,700	31	4,680	38	5,600	7	4,800	31	3,000	4,160	....
*	3,123	....	4,733	....	5,667	....	4,680	....	3,650	4,429	....

*Average unfertilized.

[1] Unfertilized.

[2] Fertilized, except plot 2.

[3] Fertilized in full.

[4] Data unreliable.

SUMMARY OF INCREASE IN ROTATED CROPS.

In Table XVIII is given the average increase from fertilizers in the crops of this rotation, with the total value of such increase per acre, corn being valued at 35 cents per bushel, oats 33 cents, wheat 80 cents, hay $8.00 per ton and straw and corn fodder $3.00 per ton:

TABLE XVIII.—AMOUNT AND VALUE OF INCREASE PER ACRE IN 5-CROP ROTATION.

Plot.	Grain.			Straw.			Hay.	Total value per acre.	Cost of fertilizers.
	Corn.	Oats.	Wheat.	Corn.	Oats.	Wheat.			
	Bus.	*Bus.*	*Bus.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		
2	[4]2.5	[2]6.2	[4]0.4	[4]419	[2]460	—[4]562	[1]1673	....	....
3	[1]9.2	[1]1.1	[4]2.4	[1]593	[1]368	[4]797	[3]475	....	....
*	3.8	4.5	1.4	454	429	217	775	$8.70	$5.47
5	[1]5.3	[1]3.1	[4]4.2	[1]553	[1]1500	[4]1174	[3]276	12.17	9.72
6	[1]8.1	—[1]4.3	[4]0.6	[1]207	—[1]260	[4]292	[3]397	3.97	4.00

*Average of 2 and 3. [1] One crop. [2] Average of two crops. [3] Average of 3 crops. [4] Average of four crops.

These figures will doubtless be considerably modified by the results of future cropping. The work in continuous culture has forcibly illustrated the danger of drawing general conclusions from the results of a single harvest; but in the majority of cases the figures in this table represent but one season's outcome. They are published as a report of progress, and for future reference. So far as they go they support the general and reasonable belief that a large part of the benefit from commercial or other manures is to be realized in the crops not directly fertilized, in a well planned rotation.

CO-OPERATIVE EXPERIMENTS WITH FERTILIZERS ON CORN.

Co-operative experiments with fertilizers on corn were made in 1893, as in 1891 and 1892, in Columbiana, Washington and Butler counties, thus representing the extreme eastern, south-eastern and south-western parts of the State.

Tables XIX to XXIV give the plan and results of these experiments, the superphosphate being in all cases dissolved bone black and used at the rate of 320 pounds per acre, the muriate of potash being used at the rate of 80 pounds per acre in 1891 and '92, and 160 pounds per acre previous to 1891; the nitrate of soda at the rate of 160 pounds per acre, the barnyard manure at the rate of 8 tons per acre and the land plaster at the rate of 400 pounds per acre.

FARM TEST IN COLUMBIANA COUNTY.

Made by H. Y. Bentley.

This test has been repeated six years in succession on the same land and under the personal superintendence of the Agriculturist of the Station. The land is high upland and underlaid with slaty rocks, which give partial drainage. Previous to 1888 it had been in pasture for several years, but the growth of grass (chiefly blue grass) had become quite uneven. Tables XIX and XX give the yield of grain and stalks for the six years:

TABLE XIX.—FERTILIZERS ON CORN IN COLUMBIANA COUNTY.

Yield and increase of GRAIN *in bushels of 70 lbs. ears*

Plot No.	Fertilizers.	Yield per acre.							Increase or decrease (—) per acre.							Plot No.
		1888	1889	1890	1891	1892	1893	Average.	1888.	1889.	1890.	1891.	1892.	1893.	Average.	
1	None	35.5	52.9	20.4	21.3	16.0	5.7	25.3								1
2	Superphosphate	35.9	56.4	18.3	22.4	15.7	4.1	25.5	—2.3	1.8	—2.6	—2.0	—2.1	—2.0	—1.5	2
3	Muriate of potash	39.4	56.2	19.5	27.3	18.1	5.9	27.7	—1.6	0	—1.8	—0.3	—1.8	—0.5	—1.0	3
4	None	43.7	57.9	21.8	30.7	21.3	6.8	30.4								4
5	Nitrate of soda	70.8	58.5	30.2	38.2	26.5	5.4	38.3	18.1	—2.0	8.1	6.4	5.1	—1.8	5.6	5
6	Nitrate and superphosphate	90.0	62.2	30.1	37.5	23.8	6.7	41.7	28.4	—1.0	7.6	4.5	2.2	—0.4	6.8	6
7	None	70.6	65.8	22.8	34.1	21.7	8.1	37.2								7
8	Superphosphate and potash	70.6	62.8	14.9	23.7	15.9	7.3	32.5	—0.1	—1.8	—8.1	—8.8	—6.1	—1.2	—4.3	8
9	Nitrate and potash	90.4	67.0	31.7	39.0	26.5	9.6	44.0	20.0	3.6	8.4	8.1	4.1	0.6	7.5	9
10	None	70.2	62.2	23.5	29.3	22.7	9.4	36.2								10
11	Superphos., potash and nitrate	74.8	66.1	24.9	31.9	24.3	9.3	38.5	7.7	5.4	1.4	2.7	2.5	0.4	3.4	11
12	Barnyard manure	61.8	73.8	30.6	28.5	22.7	6.9	37.4	—2.1	14.5	7.0	—0.7	2.4	—1.5	3.3	12
13	None	60.8	57.8	23.6	29.1	19.1	7.9	33.1								13
14	Land plaster	60.0	59.9	20.5	23.5	15.4	6.3	31.0	—0.8	2.1	—3.1	—5.6	—3.7	—1.6	—2.1	14
	Average of unfertilized plots	56.2	59.3	22.5	28.9	20.2	7.6	32.4								
	Average increase from fertilizers								7.5	2.5	1.9	0.5	0.3	—0.9	2.0	

TABLE XX.—FERTILIZERS ON CORN IN COLUMBIANA COUNTY.

Yield and increase of STALKS, *in pounds, per acre.*

Plot No.	Fertilizers.	Yield per acre.							Increase or decrease (—) per acre.							Plot No.
		1888.	1889.	1890.	1891.	1892.	1893.	Average.	1888.	1889.	1890.	1891.	1892.	1893	Average.	
1	None	4,520	2,797	1,914	2,170	2,285	1,200	2,481	....	....	....	....	....	....	....	1
2	Superphosphate	4,640	2,778	2,064	2,592	2,175	1,140	2,565	37	— 82	246	372	—139	—143	48	2
3	Muriate of potash	5,050	3,001	2,125	2,934	2,282	1,320	2,785	363	77	402	663	— 60	— 47	233	3
4	None	4,770	2,987	1,627	2,321	2,371	1,450	2,588	....	....	....	....	....	....	....	4
5	Nitrate of soda	5,800	3,030	2,585	2,868	2,531	1,220	3,006	1,093	— 55	869	421	169	—263	373	5
6	Nitrate and superphosphate	6,030	3,167	2,555	3,180	2,406	1,520	3,143	1,387	— 15	751	607	53	— 3	463	6
7	None	4,580	3,280	1,893	2,699	2,344	1,550	2,724	....	....	....	....	....	....	....	7
8	Superphosphate and potash	5,390	3,502	2,417	3,833	2,153	1,240	3,089	683	253	481	1,111	—209	—360	326	8
9	Nitrate and potash	6,590	3,549	2,762	3,192	2,607	1,600	3,383	1,757	330	783	446	228	— 50	582	9
10	None	4,960	3,188	2,022	2,770	2,397	1,700	2,840	....	....	....	....	....	....	....	10
11	Superphosphate, potash and nitrate	6,500	3,346	2,285	3,188	2,538	1,620	3,246	1,350	210	461	393	186	— 57	4 4	11
12	Barnyard manure	5,140	3,757	2,595	3,828	2,474	1,570	3,227	—200	673	969	1,009	168	— 83	422	12
13	None	5,530	3,032	1,428	2,844	2,261	1,630	2,787	....	....	....	....	....	....	....	13
14	Land plaster	5 810	3,028	1,520	2,480	2,080	1,480	2,733	280	— 4	92	—364	—181	—150	54	14
	Average of unfertilized plots	4,872	3,057	1,777	2,561	2,332	1,506	2,682	....	....	....	....	....	....	....	
	Average increase from fertilizers	....	....	....	....	....	....	....	750	231	561	518	24	—128	326	

These tables show that there has been a steady decrease in the yield of corn in this experiment, and that both chemical fertilizers and barnyard manure have utterly failed to maintain the land in a profitable state of productiveness. Of the general character of this soil the owner of the farm on which this test has been made (Mr. Hickman) states:

"A fair crop of corn may be grown on the shaly hills—on one of which this test is located—once in six or seven years, by following a rotation of corn, oats and wheat, followed by one year in meadow and two to four years' pasturing with sheep. Blue grass (*Poa pratensis*) is native, and when the hills are well set in this grass they furnish the best of pasture, which will last indefinitely. One field on this farm has been grazed continuously for thirteen years, and gives promise of continuous good pasture."

Corn grown on sod on this farm in 1893 yielded a fair crop—sixty shelled bushels per acre—while that grown in continuous culture was practically a total failure.

FARM TEST IN BUTLER COUNTY.

Made by B. H. Brown.

Mr. B. H. Brown, of Oxford, Butler county, has made this experiment in 1889, 1891, 1892 and 1893, but each time on fresh ground, the tests of 1889 and 1893 being made on wheat stubble, and those of 1891 and 1892 on timothy sod. The soil is a heavy clay of drift origin. O. the test of 1893 Mr. Brown writes:

"The corn was planted June 10, on stubble ground where grasshoppers had killed the clover. The field was plowed early and was harrowed and laid off twice in May, ready to plant, and then heavy rains came and the work had to be done again. When it was planted the ground, naturally wet, was run together and was hard as the road. The fertilizer was applied around the hill on June 20 and cultivated in, but after this time we did not have enough rain to dissolve all of it, so it did very little good."

The results of the four tests are given in Tables XXI and XXII; from which it will be seen that in the average of the tests made on this farm potash has seemed to produce exceptionally good results, but no form of chemical manures has equaled barnyard manure in the average increase.

TABLE XXI.—FERTILIZERS ON CORN IN BUTLER COUNTY.

Yield and increase of GRAIN *in bushels of 70 pounds of ears.*

Plot No.	Fertilizers.	Yield per acre.					Increase per acre.					Plot No.
		1889.	1891.	1892.	1893.	Average.	1889.	1891.	1892.	1893.	Average.	
1	None	18.3	21.4	42.6	23.6	26.5						1
2	Superphosphate	35.9	39.6	42.9	26.7	36.3	15.1	15.4	0.3	3.9	8.7	2
3	Muriate of potash	41.7	32.3	62.1	28.6	41.2	18.3	5.3	19.5	6.5	12.4	3
4	None	25.9	29.9	42.6	21.3	29.9						4
5	Nitrate of soda	26.7	41.4	51.3	27.1	36.6	0.2	12.2	8.8	4.8	6.5	5
6	Nitrate and superphosphate	35.7	41.6	52.1	30.0	39.8	8.6	13.0	9.6	6.7	9.5	6
7	None	27.7	27.9	42.4	24.3	30.6						7
8	Superphosphate and potash	49.9	37.5	51.0	28.3	41.7	23.7	8.7	9.5	4.3	11.5	8
9	Nitrate and potash	37.9	47.7	51.4	29.3	41.6	13.1	18.1	10.3	5.6	11.8	9
10	None	23.3	30.5	40.9	23.4	29.5						10
11	Superphosphate, potash and nitrate	48.0	51.4	45.9	25.0	42.6	22.7	22.6	4.4	2.4	13.1	11
12	Barnyard manure	67.4	60.7	60.7	29.6	54.6	40.0	33.6	18.7	7.9	25.0	12
13	None	29.4	25.4	42.6	20.9	29.6						13
14	Land plaster	33.3	30.3	44.3	21.7	32.4	3.9	4.9	1.7	0.8	2.8	14
	Average of unfertilized plots	29.4	27.0	42.2	22.7	29.2						
	Average increase from fertilizers						16.2	14.9	9.2	4.8	11.3	

TABLE XXII.—Fertilizers on Corn in Butler County.

Yield and increase of STALKS *in pounds per acre.*

Plot No.	Fertilizers.	Yield per acre.					Increase per acre.					Plot No.
		1889.	1891.	1892.	1893.	Average.	1889.	1891.	1892.	1893.	Average.	
1	None	1,320	1,652	2,710	2,200	1,970						1
2	Superphosphate	2,690	1,952	2,650	2,410	2,425	1,193	417	10	277	474	2
3	Muriate of potash	2,700	1,683	4,210	2,900	2,873	1,027	266	1,640	833	942	3
4	None	1,850	1,300	2 500	2,000	1,912						4
5	Nitrate of soda.	2,000	1,447	2.800	2,100	2,087	67	—20	383	100	133	5
6	Nitrate and superphosphate	2,650	2,020	2,950	2,390	2,502	633	387	617	390	507	6
7	None	2,100	1,800	2,250	2,000	2,037						7
8	Superphosphate and potash	3,400	1,761	3,250	2.200	2,652	1,417	—93	950	137	603	8
9	Nitrate and potash	2,550	2,034	3,200	2,400	2.546	683	125	850	274	483	9
10	None	1,750	1,963	2,400	2,190	2,076						10
11	Superphosphate, potash and nitrate	3,370	2,173	2,990	2,050	2,646	1,530	205	557	—76	554	11
12	Barnyard manure	4,680	2,835	3,980	2.400	3,474	2,750	863	1,513	337	1,366	12
13	None	2,020	1,977	2,500	2,000	2,124						13
14	Land plaster	2,380	1,869	2,700	1,980	2,232	360	—108	200	—20	108	14
	Average of unfertilized plots	1,808	1,738	2,472	2,078	2,505						
	Average increase from fertilizers						1,074	227	747	250	574	

FARM TEST IN WASHINGTON COUNTY.

Made by Orlando Trotter.

Mr. Orlando Trotter, of Layman, Washington county, made this test in 1891 and 1892, but on different land each time—a timothy sod in 1891 and a wheat stubble with one year's growth of clover in 1892. In 1893 the test was repeated on the same land on which it was made in 1892. Following is Mr. Trotter's description of the treatment of the land and of the crop:

"After the corn was taken off in 1892 the ground was sown to rye, with commercial fertilizer at the rate of 200 pounds per acre. It was sown late and did not make much growth last fall owing to drought. It thickened up in the spring and was a good stand; was plowed under May 20, when in full bloom; the ground was prepared at once and planted, 3 grains in a hill, 42 inches apart. One-half of the fertilizer was applied in the hill, the other broadcasted on the lots and worked in. The corn was cultivated four times and hoed. It was cut September 22 and husked October 30. The corn was very poor, not more than half a crop, compared with last year. The entire crop of this section of country is about the same—on low ground about two-thirds of a crop, on the hills from one-third to half a crop."

The results of this test are given in Tables XXIII and XXIV:

TABLE XXIII.—FERTILIZERS ON CORN IN WASHINGTON COUNTY.

Yield and increase of GRAIN *in bushels of 70 pounds of ears.*

Plot number.	Fertilizers.	Yield per acre.				Increase or decrease (—) per acre.				Plot number.
		1891.	1892.	1893.	Average.	1891.	1892.	1893.	Average.	
1	None	33.9	28.3	13.5	25.2					1
2	Superphosphate	50.5	25.7	15.7	30.6	15.5	—2.0	2.5	5.3	2
3	Muriate of potash	47.3	22.6	14.2	28.0	11.6	—4.6	1.2	2.7	3
4	None	37.3	26.6	12.7	25.5					4
5	Nitrate of soda	46.1	31.7	16.2	31.3	8.6	6.4	2.7	5.9	5
6	Nitrate and superphosphate	51.2	41.4	23.3	38.6	15.5	17.5	9.0	13.3	6
7	None	37.9	22.6	15.1	25.2					7
8	Superphosphate and potash	47.2	21.4	18.3	29.0	7.9	—3.0	3.3	2.7	8
9	Nitrate and potash	47.8	43.1	22.4	37.8	7.1	16.9	7.5	10.5	9
10	None	42.1	28.0	14.7	28.3					10
11	Superphosphate, potash and nitrat	48.8	60.3	28.3	45.8	8.0	31.2	13.0	17.4	11
12	Barnyard manure	48.0	37.1	23.2	36.1	8.6	6.8	7.4	7.6	12
13	None	38.0	31.4	16.4	28.6					13
14	Land plaster	48.9	26.6	18.3	31.3	10.8	—4.8	1.9	2.7	14
15	Bowker's superphosphate, 100 pounds		26.3				—5.1			15
16	" " 200 "		25.0				—6.4			16
	Average of unfertilized plots	37.9	27.4	13.3	26.6					
	Average increase from fertilizers					10.2	7.2	5.4	7.6	

TABLE XXIV.—FERTILIZERS ON CORN IN WASHINGTON COUNTY

Yield and increase of STALKS *in pounds per acre.*

Plot number.	Fertilizers.	Yield per acre.				Increase or decrease (—) per acre.				Plot number.
		1891.	1892.	1893.	Average.	1891.	1892.	1893.	Average.	
1	None	1,731	2,780	1,450	1,987					1
2	Superphosphate	1,913	2,520	1,450	1,961	252	—167	108	64	2
3	Muriate of potash	1,890	2,700	1,175	1,922	300	107	—58	116	3
4	None	1,520	2 500	1,125	1,715					4
5	Nitrate of soda	1,905	2,160	1,135	1,733	330	—267	19	28	5
6	Nitrate and superphosphate	1,771	2,860	1,325	1,985	141	507	217	288	6
7	None	1,685	2,280	1,100	1,688					7
8	Superphosphate and potash	1,970	2,640	1,875	2,162	222	340	742	435	8
9	Nitrate and potash	1,850	2,640	1,350	1,947	40	320	183	181	9
10	None	1,873	2 340	1,200	1,804					10
11	Superphosphate, potash and nitrate	1,815	3,020	1,725	2,187	—11	647	450	363	11
12	Barnyard manure	1,962	2,680	1,975	2,206	184	273	625	361	12
13	None	1,731	2,440	1,425	1,865					13
14	Land plaster	1,892	2,520	1,510	1,974	161	80	85	109	14
15	Bowker's superphosphate, 100 pounds		2,350				—90			15
16	" " 200 "		2,630				190			16
	Average of unfertilized plots	1,708	2,468	1,260	1,812					
	Average increase from fertilizers					180	204	263	216	

THE SOURCE OF PHOSPHORIC ACID IN FERTILIZERS.

In the experiments at Columbus, phosphoric acid has been applied to the crops in continuous culture in three different forms, namely: dissolved bone-black, acid phosphate and basic slag.

Dissolved bone-black is bone charcoal which has been treated with sulphuric acid, thus making a superphosphate containing about 16 per cent. of phosphoric acid. The object of treating the charcoal with sulphuric acid is to make the phosphoric acid readily soluble in water, as in the condition in which it is found in raw bone or untreated bone ash or charcoal it dissolves very slowly.

Bone-black is largely used in the refining of oil and sugar, and is ordinarily treated with acid and sold for a fertilizer after having been used in the refineries. It can be bought in Ohio markets at an average cost, including freight, of about $22 per ton, making its phosphoric acid cost about 7 cents per pound.

Acid phosphate is a superphosphate made by treating the crude Carolina rock with sulphuric acid, the object being the same as in the making of superphospate from bone-black. It should contain about 14 per cent. of phosphoric acid.

Acid phosphate is largely distributed from Baltimore, and may be bought there at $12 per ton. The average freight to Ohio in less than car-load lots is about $5 per ton, which would increase the cost in Ohio to $17, making the phosphoric acid cost about 6 cents per pound.

Basic slag, otherwise known as "odorless phosphate," is a fine meal made as a by-product in the making of steel from ores rich in phosphoric acid. It should contain about 20 per cent. phosphoric acid.

Basic slag is controlled by a patent, and is sold in Philadelphia at $18 per ton, or $23 with freight added to Ohio, making its phosphoric acid cost 5¾ cents per pound.

In car-load lots each of these materials may be bought at a reduction of one to three dollars per ton, and the freight will also be reduced. By the single bag the price is one or two dollars per ton higher.

In Table XXV is given the average increase per acre on Plots 11, 17 and 18 of the tracts devoted to the continuous culture of corn, wheat and oats, the tests extending over six seasons in the case of corn, five seasons for wheat and four seasons for oats:

TABLE XXV.—INCREASE FROM DIFFERENT FORMS OF PHOSPHORIC ACID.

Plot.	Fertilizer.	Increase per acre.					
		Grain.			Straw.		
		Corn.	Wheat.	Oats.	Corn.	Wheat.	Oats.
		Bus.	*Bus.*	*Bus.*	*Lbs.*	*Lbs.*	*Lbs.*
11	Dissolved bone-black...........	4.3	4.0	5.6	383	1,509	253
17	Acid phosphate..................	7.3	4.2	5.5	867	945	507
18	Basic slag..........................	7.2	4.6	7.0	686	1,017	444

The plot receiving basic slag has had a somewhat larger total quantity of phosphoric acid per acre and that receiving acid phosphate a somewhat smaller quantity than that applied in the bone-black, but apparently the phosphoric acid found in the ancient, fossil bone of the Carolina rock is equally efficacious, pound for pound, with that found in the bones of modern animals, when both have been converted into superphosphate, and the mineral phosphoric acid of the basig slag is not inferior to the most active forms of the same substance as derived from bones.

Attention is called, however, to the relative increase of straw of wheat as shown in the diagram on page 8. Should some way be discovered by which the greater growth of straw, produced by the bone-black superphosphate, may be made to bear a proportionate quantity of grain a greater value would have to be assigned to that form of phosphoric acid than the results thus far attained will justify; but at present this excessive production of straw must be looked upon as a disadvantage, in the light of the results in 1891, when every plot dressed with bone-black superphosphate gave a smaller yield of grain than the unfertilized plots adjoining, although the straw was enormously increased, while the rock and slag phosphates gave a more moderate increase of straw with a small increase of grain.

FIELD EXPERIMENTS WITH FERTILIZERS IN WAYNE COUNTY.

It is intended that the field study of the general problem of the maintenance of fertility shall continue to be one of the leading features of the Station's work, and for this purpose about twenty-eight acres of land has been prepared by thorough draining and plotting on the general plan hitherto followed. In this work special attention will be given to rotative cropping, and two rotations are being started, in one of which corn, oats, wheat, clover and timothy are to be grown in a five-crop rotation, and in the other, potatoes, wheat and clover in a three-crop system. In addition to these rotations, corn, oats and wheat will be grown in continuous culture.

Oats and corn were planted in the five-crop rotation and in continuous culture in the spring of 1893, but the experiments were rendered of no value by the excessive drouth of that season, the average unfertilized yield of corn being but twenty shelled bushels per acre, and the average yield of the fertilized plots less than two bushels more. It is hoped that the climatic conditions may be more favorable in 1894.

SUMMARY.

The experiments reported in this bulletin cover five years' continuous culture of wheat and oats on the farm hitherto occupied by the Station at Columbus and belonging to the State University; six years' continuous culture of corn on that farm and in Columbiana county, and three to five years' intermittent culture of corn in Washington and Butler counties. In previous bulletins other co-operative experiments have been reported from five other counties of the State. In all, twenty-one separate experiments have been made with corn, eight with wheat and five with oats, each including fourteen to twenty-eight plots. The experiments have been made on soils varying widely in character, and including some of extreme poverty.

We are as yet only at the beginning of this work. Each year's results serve to emphasize the necessity for long continued, systematic investigation before attempting to formulate any general law; but our results thus far point most forcibly to the conclusion that:

At present prices of cereal crops and of fertilizing materials respectively, the profitable production of corn, wheat and oats upon chemical or commercial fertilizers, or upon barnyard manure, if its cost be proportionate to that of the chemical constituents of fertility found in commercial fertilizers, is a hopeless undertaking, unless these crops be grown in a systematic rotation with clover or a similar nitrogen-storing crop; and the poorer the soil in natural fertility the smaller the probability of profitable crop production by means of artificial fertilizers.

Drainage and thorough tillage are the logical preliminaries to any profitable system of agriculture. When these agencies of amelioration have been systematically employed, the great sheet of drift clay which covers so large a part of Ohio is found to be a mine of fertility.

BULLETIN

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STRAWBERRIES.

BY W. J. GREEN AND E. C. GREEN.

Experiments with strawberries have occupied a prominent place in the horticultural work of this Station from the beginning, and inquiries concerning the best methods of management have been numerous. Many of these questions are repeated from year to year, and hence it is thought best to give some brief cultural directions, especially such as our experiments have thrown some light upon, not all of which have been treated in former bulletins. The discussion of topics is somewhat brief, nor are all points in strawberry culture touched upon, for it is not designed to prepare a manual on the subject, but rather to offer a few suggestions here and there, which, if not altogether new, are least often treated in the literature of the subject.

CHOICE OF SOIL AND LOCATION.

Almost any good soil, reasonably free from frost, will do for strawberries, and yet there are decided differences in soils which cannot be detected, except by actual trial. Good drainage and a reasonable amount of fertility are both essential, but the range in composition may be all the way from light sand to heavy clay, although neither extreme is desirable, particularly the former. A soil infested with white grubs is not suitable, and these are most likely to be found in grass lands; sometimes in clover fields, and less frequently in cultivated ground. Whether the exposure should be to the north, south, east or west is not important, except as it affects the time of ripening, but it is well to avoid sites where the wind has full sweep.

PREPARATION OF THE SOIL AND FERTILIZERS.

If the drainage is not good it must be attended to first of all, and fertilizers should be applied up to a point sufficient to produce a good crop of wheat or corn. There is little danger in excessive manuring, except that the young plants may be killed with commercial fertilizers, placed too closely about the plants, or coarse, strawy manure may have the same effect. In some experiments conducted at this Station with fertilizers, it was found that superphosphate, nitrate of soda and sulphate of potash, used too freely at planting time, killed some of the plants, but had no effect on the grubs. The injury of the grubs was least apparent where fine manure was used, although they worked on all plots; the reason for this being that the manure stimulated a growth of runners to replace the plants lost. This shows the fallacy of the belief that commercial fertilizers drive away or destroy grubs, or shows, at least, that they have no practical value for that purpose. Our choice of fertilizers are well rotted manure, bone meal and unleached wood ashes. Nitrate of soda stimulates growth, but seems not to add greatly to the crop unless other food elements are present in sufficient quantity. Alone it is not profitable, nor is it needed where manure and bone are used freely.

The objection often urged against manure that it brings in, or favors white grubs, is not sustained by our experiments, but the contrary is true. The best way to deal with these pests is not to plant where they are known to be present, but if this is unavoidable the next best thing to do is to destroy them as fast as found, and to stimulate the plants with plenty of manure.

The usual way is to plow the ground in the spring and plant at once, but a better way is to plow in the fall, turning under a coating of manure and then top-dress at once, or during the winter. It is not essential that the top-dressing should be thoroughly rotted, as the coarser parts can be raked off in the spring. This plan of mulching the soil during the winter is very satisfactory, particularly with strawberries It delays the work of planting a few days in the spring, but that is not a matter of importance with this crop. The ground should not be plowed again in the spring, but put in order with the cultivator and harrow. Soil treated in this manner will endure drought much better than if plowed in the spring. When spring plowing is necessary the roller should be used to compact the soil, as if let loose and open the wind and sun dry it out quickly, which endangers the young plants, before they become established.

WHEN TO SET STRAWBERRY PLANTS.

The belief is common that August is the best time to plant, but in this latitude the spring is better in every way. At the Station we are obliged to set new beds both fall and spring. With spring planting there have been but few poor crops, while with fall planting there have been but few good ones; never more than half crops and usually less. The best known means have been employed to grow plants early so as to set in August, but dry weather has usually prevented them making a good growth, often killing them outright. When there is sufficient rainfall during July, August and September, fall planting may be fairly successful, but such seasons are rare, and the chances of success are correspondingly reduced.

Early spring in this latitude during April and May is the safest and best time of the whole year to set strawberry plants.

If a bed must be set in the fall, preparations should be made in time in order to the best success. The ground should be put in order in July, and kept in readiness for the plants when they are fit to be put out, or some early crop can be grown that can be cleared off in time and then fitted at once, and kept clean until planting time.

Plants should be grown especially for the purpose, as those taken from the field are seldom mature enough at the beginning of August, which is the date planting should be done, if possible.

Potted plants are usually considered essential, and if properly grown they are the best. A plant which has been stuck into a pot for a few days and taken out before it is fairly rooted is no better than an ordinary layer, nor is a pot bound plant worth much more.

The surest way to get plants early is to remove the young runners, or tips, from the parent plants before they have fairly rooted, and plant them in a shady place where they may be watered frequently. They will soon take root, and be ready to set in the field in two or three weeks. A simple frame covered with cloth is sufficient; in other words a cold frame. If watering is attended to, success is sure. As a matter of experience it has been found that it is much easier to grow the plants than to hit upon suitable weather for planting in the field. Could this be assured it would be better to pot the young plants and transfer to the field when the pots became well filled with roots, but dry weather often holds on so long that the plants become pot bound and nearly ruined before rain comes.

On the whole, it is just as well to dispense with pots and simply grow the plants in soil, to be set in the field as soon as the weather is suitable. We have abandoned the method of plunging pots alongside the rows, in which to root the runners, as unsatisfactory. There are occasional seasons when the rainfall is sufficient to admit of setting plants at almost any time, and in such cases they may be taken from the beds where they grow and planted at once in the field. When this can be done it answers as well as to take special pains to propagate them, but such occasions are very rare.

HOW FAR APART SHOULD THE PLANTS BE SET?

The space between plants depends upon the method of culture and training to be pursued. If the runners are to be removed, and the plants kept in hills, one foot apart in the rows is sufficient, and the rows need not be more than three feet apart, or still closer in some cases. If the plants are allowed to run and form matted rows, then eighteen inches by four feet is about the proper distance. If the plants are very strong and are set early, in fact, if all the conditions are favorable, the plants may be set two feet apart in the row with assurance that a full matted row will be formed before fall.

A plan has been tried here of setting plants in the fall in narrow beds, eighteen to twenty-four inches wide, leaving an alley about two feet wide between beds. The plants are placed about six inches apart each way. This plan is quite satisfactory where the plants are to be kept one year only, but is not advisable if to be left longer.

METHODS OF TRAINING.

The most common method is to allow the plants to grow at will, forming matted rows from one to two feet wide. There are two modifications of this plan, the principle in both cases being to thin the plants. In one case the early runners are cut off and the later ones placed at somewhat regular intervals, from four to six inches apart, along the rows. In the other case the plants are not thinned until near the close of the season. The first plan requires more labor than the second, besides there is a possibility of dry weather checking the late growth, so that the loss of the early runners cannot be made good, resulting in a poor stand of plants.

The hill system consists in removing the runners during the entire season. In our trials of this method we have found that there is much danger of losing many plants by white grubs, and not having runners to replace the loss, a poor stand is often the result. To grow the finest possible berries the runners must be thinned, or cut away altogether, except on fall set plants, where the runners are not usually numerous enough to necessitate their removal.

HOW LONG SHOULD A BED BE KEPT IN BEARING.

It is the practice at the Station to keep the beds two, and sometimes three years, as some varieties do better the first season, while others fruit better the second season. In general, varieties fruit more freely the second than the first season, and the berries are correspondingly smaller. This is an advantage in the case of some of the large fruited, shy bearing sorts, but quite the reverse with some of the best market varieties, which are none too large at best. With some of the first class it matters little how long they are kept, so long as the plants remain healthy.

For home use it is not a matter of importance as to the length of time a bed is kept, but for market there is seldom much profit in keeping a bed of any of the prolific, medium sized sorts more than one season. It usually costs less to plant a new bed than to clean out an old one, and it is much easier to keep the new bed clean. It is often claimed, as an argument in favor of old beds, that the earliest berries come from them, which is true; but it is also a fact that the berries are smaller than from new beds, which more than offsets all possible gain in the matter of earliness, in the case of most varieties. The single fact that old beds are nurseries for insects and diseases is enough to condemn them. A bed that has borne one or two crops and appears to be in good condition is often deceiving. It is seldom as good as it looks to be. It yields to insects and diseases more easily than a new bed, and is more likely to disappoint than not. If a bed is to be kept another season, then the question arises,

HOW SHALL WE TREAT AN OLD BED?

The plan most in favor here and with many practical growers is to mow the tops off the plants and burn on the bed as soon as dry. This treatment is the best possible way to check the rust. In case the bed has been heavily mulched, the straw and leaves should be raked into the center of the rows before burning, particularly in very dry weather, when there is some danger of injuring the plants by too great heat. Beds planted in orchards cannot be treated in this manner without endangering the trees.

After burning, the ground between the rows should be kept thoroughly worked with a cultivator. This plan is decidedly better than plowing and harrowing, as sometimes practiced, as the bed is not only cleared of trash more effectually, but the succeeding growth is healthier, besides shallow stirring of the soil with the cultivator is better than deep working with a plow. This work should be done as soon as the berries are picked, for if left too long the plants do not have sufficient time to recuperate before winter. The same is, of course, true whatever treatment is given.

WINTER PROTECTION.

Strawberry plants are hardy and do not need a covering to keep them from freezing, but on some soils a mulch is beneficial to prevent the plants from heaving. A mulch is useful in the summer to retain the moisture, and to keep the berries clean. The fall or early winter is the best time to place the mulch, although it may be applied in early spring. Straw is commonly used, but it is objectionable because of the grain and weed seeds which it contains. Where leaves are near at hand it will pay to use them, but it will be necessary to throw some straw over them to hold them down, especially where the wind has full sweep. The best material of all is marsh hay, as it is free from weed seeds and is not easily blown off by the wind. It is much cheaper than straw at the same price per ton, as a given quantity will go farther than the same weight of straw. The cost of keeping a straw-mulched bed free from weeds is often sufficient to pay for the trouble of getting swamp hay which is about all that it usually costs.

SHOULD THE MULCH BE REMOVED IN THE SPRING AND THE GROUND CULTIVATED?

This is a matter concerning which there is difference of opinion. Some advocate the removal of the mulch in order to lessen the danger of frost. Experiments conducted at this Station some years ago to determine the effect of mulch in reducing temperature, showed that it does have that effect to some extent, and that frost is more likely to occur on mulched than on unmulched surfaces. The difference does not appear to be sufficient, however, to warrant the removal of the mulch to prevent frost. Removal for the sake of cultivation has been tried, but so many different circumstances have to be taken into consideration that the question becomes too complicated to settle in a general way. When the bed is foul in the fall, with weeds which live over winter, such as chick weed and shepherd's purse, or grasses, there seems to be no other way to clean it in the spring than to remove the mulch and cultivate. On sandy soils this works better than on heavy clay. Our own trials have been confined to the latter, and it has been found that if worked too soon the soil is made cloddy. The same is true if the ground is allowed to get too dry before working. If worked when in the right condition and covered at once with mulch, some labor is saved in keeping down weeds, but it is a matter of doubt if the other benefits are very great. It is probable that the character of the soil has as much to do with the good or bad effects of spring cultivation as anything. It surely is not to be recommended under all circumstances and conditions, and yet it may work well in others.

PROPAGATING NEW VARIETIES FROM SEEDS.

Most of the varieties now before the public are chance seedlings, discovered by accident, or grown from seed gathered at random. A few are the result of crosses of well known varieties. Most originators have been content to gather seeds from the finest berries of the best varieties, knowing the parentage on one side only. Others have taken considerable pains to make crosses so as to know the parentage of all seedlings.

Both methods have been practiced at this Station, but by far the most satisfactory results have been obtained by making crosses of the best varieties. The largest proportion of good seedlings has been obtained in this manner. One lot of less than one thousand seedling plants, mostly from a cross of Sharpless and Crescent, contained more promising varieties than another lot of ten thousand from seed gathered in the usual manner. It is true that all were finally rejected, but from the small lot as fine berries could be gathered as from the best named sorts. There were a number of seedlings that were much better than most of the named kinds, while those from the other lot were inferior. This is an isolated fact and it may not always hold good in the same degree, but it is no doubt true that the surest way to get good seedlings is to use the best varieties in making crosses, rather than to gather seed at random.

One purpose in such work at this Station is to learn what varieties to use in making crosses. At present no one can predict what the result will be in any given cross, whether it should be Sharpless X Crescent, Cumberland X Crescent, or some other combination no one can tell, but it seems probable that some crosses will give more good seedlings than others. Originators are urged to follow more exact methods than they have hitherto, not only that they may secure better results, but that facts may be learned which will be useful in future work.

SELECTION OF VARIETIES.

This is a matter of the utmost importance, and one of considerable difficulty, and yet not so hard as it seems to be. First of all one must fix in his mind what it is he wants in a variety, and then select the one that is most generally successful, which comes nearest to the standard. The fact that varieties vary more or less upon different soils, and in the same locality in succeeding seasons, is a bugbear with many. The important fact is overlooked that all varieties are not alike in degree of variability, that a few are practically the same on all kinds of soil, while others vary greatly from year to year on the same soil. By giving no heed to the glowing descriptions of dealers, leaving entirely alone those upon which reports are conflicting, and testing in a small way those that are spoken of most favorably, after one or two seasons' trial, in various localities, one need not have much trouble in finding reliable varieties.

The list of varieties that succeed under widely different conditions is a short one, but it contains about all that are worth bothering with. It is true, as often stated, that everyone must do more or less testing for himself, for no one can tell just what varieties will suit him and prove to be best adapted to his soil, but it does not follow that the results of others are worth nothing to him. They may have value if properly interpreted, and the interpretation to put upon such results is, that whatever weakness a variety shows at any time or place is altogether likely to appear elsewhere. Keeping this in view one can easily decide what varieties not to try, resting assured that the loss by so doing will be less than the gain.

The fact of the sexuality of strawberries is well known, but the proper proportion of perfect and imperfect flowered sorts to plant is an open question. Varieties and seasons have much to do with the matter, hence no definite rule can be given. About one-fifth of pollen-bearing sorts is usually sufficient, and it is well to mate the two sexes as to time of blooming and color, size and firmness of fruit, as nearly as possible.

The most prolific sorts are found among those having imperfect flowers, notwithstanding the fact that many of this class are not prolific, while some of the other class are quite so. It is a fact that the best of the imperfect-flowered are better than the best of the perfect-flowered, not only as to prolificacy, but as to freedom from disease and general reliability.

Many of the perfect-flowered kinds bloom as freely and set as many berries as any of the other class, but they are more apt to succumb to drought and unfavorable influences; in other words are not so likely to carry a crop through to perfection as those that bear no pollen. This fact is so well understood by growers that the general custom is to plant as few as possible of perfect flowered kinds, and there are numerous and urgent inquiries after the most prolific and reliable of this class, showing that something better is wanted.

NOTES ON VARIETIES.

Owing to the removal of the Station from Columbus to Wooster, no satisfactory report could be made in 1893, hence the following notes combine the results of 1893 and 1894, both on the old and new grounds. The soil at Columbus is a clay loam with considerable lime, while that of the present site has less lime and more sand, and is known as chestnut land. It is sufficiently elevated to be comparatively free from frost, and is admirably adapted to fruit culture.

It may be objected to such soil that it is too good for variety testing, which is in some sense true, but the objection often urged against the former location, that varieties might fail there and yet do well elsewhere, will not hold good for the present site.

In former reports no account was given of varieties sent in for trial, but in this they have been included. It is hoped that in future reports it will be possible to illustrate some of the best new sorts.

One feature of new variety testing is very unsatisfactory, and that is the fact that we are called upon to make reports before we have had sufficient time to make a fair test. Two years is the least possible time in which to test a variety of strawberry, and that is insufficient to do more than to give a close guess as to its probable value. This Station will soon have two branch stations, on soils quite unlike that of the central farm, which will give much better facilities than at present for variety work.

It is requested that varieties sent here for trial shall be accompanied with the name and address of the sender, and that none but those that are really thought to be worthy shall be sent.

Auburn (imperfect). Medium to large, uniform in size and regular in outline; dark red; quality good. This variety ranks high for home use, but is not sufficiently productive for market to take a place along side of such sorts as Haverland and Greenville.

Aroma (perfect). From E. W. Cruse, Leavenworth, Kansas. Berries large, usually conical but often irregular in outline; color light red; moderately firm; quality good. The plants are very vigorous, healthy and moderately productive. Although not productive as to number of berries, in quality it will probably rank high among late sorts. As a late variety it is very promising both for home use and for market, and will probably supersede the Gandy. It is rated as firm by some but it does not seem to possess that quality here. For near market, especially where fancy berries are in demand, it seems to have valuable qualities. Almost the entire crop would grade as first class, there being very few berries under one inch in diameter. It has fruited on the Station grounds three years, both in Columbus and Wooster, which may be regarded as a fairly conclusive trial, especially since the results have been practically the same in each case. It can be confidentially recommended as worthy of trial.

Beverly (perfect). Berries medium to large; of good form and color. The plants are healthy and fairly productive. The first berries would nearly all grade as fancy, but towards the last the greater portion are small, which lessens its value for market. It resembles Miner's Prolific but is less valuable.

Beder Wood (perfect). As a pollenizer this variety has some merit, but the berries are too small to suit the demands of most markets. The foliage is much subject to rust, and yet the plants produce a heavy crop of medium sized berries.

Bell's No. 3 (perfect). From Wm. Belt, Williamsburg, Ohio. Berries large, conical, rather long, regular in outline; bright red, glossy; quality good; moderately firm. Plants vigorous, healthy and quite prolific. This is one of the most promising varieties ever tested at the Station. In size and general appearance it compares favorably with the Marshall, but holds out better towards the end of the season, gives a greater number of large berries. It has been tested two seasons here and the Marshall only one, hence an opinion as to relative value would be premature. The Marshall has pretty generally been accorded a high place, and the probability is that Bell's No. 3 will take about the same rank. The variety has not been introduced but is to be soon.

Bubach (imperfect). This variety is probably planted less than formerly, because of the difficulty of getting a good stand of plants, resulting in a light yield. When properly grown it gives satisfactory results, but in many cases it is far less profitable than Haverland or Crescent. Considerable skill is required to bring it to perfection, but in most cases the labor bestowed will be well rewarded.

Brandywine (perfect). From Edward Ingraham, West Chester, Pa. Berries medium to large; short, conical; usually regular in form, but sometimes misshapen; color bright red; quite firm; quality not extra, being rather acid. In appearance the berries are hardly up to the average. The large calyx when fresh adds considerably to the effect, but in dry seasons like the past the contrary is true, for the calyx was almost always dead and unsightly. The plants are vigorous and healthy and moderately productive. The yield from the Brandywine was considerably less than from the Enhance alongside; the berries were smaller also, but of better form and more uniform and attractive in appearance. The berries hold up in size quite well to the end of the season, the greater share ranging from medium to large. It would serve well as a pollenizer to plant with Warfield or Bubach. On the whole it possesses many good qualities and is worthy of general trial, The only doubt that can be expressed concerning its value for market is as to its productiveness, but one season's trial is not sufficient to determine that point with any degree of certainty. Its free and healthy growth indicates that it will probably adapt itself to a great variety of soils.

Brunette (perfect). From Granville Cowing, Muncie, Indiana. Berries medium to large; conical to roundish, very uniform and regular in size and form; dark red, glossy and beautiful in appearance; quality excellent, comparable with the Prince of Berries in this particular; plants healthy, vigorous and fairly productive. For the home garden this variety is unequaled, and in some markets would no doubt prove profitable. The variety has been on trial several seasons and thus far stands at the head for the home garden.

Banquet (imperfect). Equal to the Brunette in quality but smaller and less prolific. It will probably take rank with the Henderson and Prince of Berries as being very good in quality, but too shy a bearer to meet the wants even of those who grow for home use only. The Brunette fills every requirement much better than the Banquet.

Cyclone (perfect). From E. W. Cruse, Leavenworth, Kansas. Berries medium to large; conical, regular in form and uniform in size; color light red; medium as to firmness and quality; plants healthy and vigorous, but the foliage is not abundant; quite prolific. In color of foliage and fruit it resembles the Haverland, but the berries are shorter and not quite so large. The greater share of the berries are above medium size, and they hold out well in size to the end of the season. On the whole, this is a very promising variety; fully equal to the Lovett in productiveness and earliness, and superior to it in appearance of fruit. It is quite as early as the Crescent and possibly a few days earlier, hence would be suitable to plant with it or the Haverland. It has fruited three years at Columbus and Wooster, and the results in each case bear out the above report. It can be confidentially recommended as worthy of general trial.

Crescent (imperfect). This thoroughly reliable variety is still planted extensively. It has faults, but its enormous productiveness makes it one of the most profitable for general purposes. The Lovett and Cyclone are probably the best varieties to plant with it.

Epping (imperfect). From George Q. Dow, North Epping, N. H. Berries medium size; conical; bright red; medium as to firmness; plants healthy and vigorous, but only moderately productive.

It has fruited here only one season, which will not justify the rendering of a judgment, but it appears to be too small, and not sufficiently prolific.

Eclipse (imperfect). Plants vigorous and healthy but not prolific. The berries are deeply pitted, bright red, sour and soft, apparently not in any way desirable.

Enhance (perfect,. This variety has not become popular. By some it is esteemed very highly, but by others it has been discarded. Ordinarily it gives good crops, but sometimes it yields very poorly. Its faults seem to have been exaggerated, however, and its value underestimated. It bears shipment well and is unexcelled for canning. Among perfect flowered sorts it is one of the most prolific, but is not equal in productiveness to the best imperfect flowered sorts.

Early Bird (perfect). From S. H. Warren, Weston, Mass. Berries small to medium in size; conical, regular in form; light red; medium as to quality and firmness; plants somewhat inclined to rust. It can hardly be classed as a first early, ripening with the Crescent, but several days later than the earliest sorts. Coming as it does in mid-season, its small size is more objectionable than if it ripened earlier, hence it can hardly be classed as promising.

Gov. Hoard (perfect). Berries large at first, but small toward the last of the season; dark red in color and quite promising, but seems to possess no qualities not found in many other varieties.

Granville (perfect). From A. M. Nichols, Granville, O. Fruited on fall set plants, which did not make a very good growth, because of the dry weather, hence did not produce much fruit. As regards size, color and general appearance of the fruit, as well as growth of plants, a favorable report can be given, and yet further trial is necessary in order to determine its merits.

Greenville (imperfect). Former reports on this variety have been favorable, and these opinions need only slight modifications. It is even more prolific and holds up in size better than was at first anticipated; on the other hand it is less firm than it was thought to be. It is especially adapted for home use and near market, for which purposes it is unexcelled. In firmness it excels Haverland and Crescent, but it is not equal to Warfield, hence its field is greatly restricted. It must be classed as one of the standard varieties, and can be recommended for general cultivation.

Gillespie (perfect). Berries large at first but run down in size after the first two or three pickings. Not desirable.

Haverland (imperfect). Now generally recognized as a standard variety. It is not without faults but its wonderful prolificacy makes it a favorite with many growers who market near at hand.

Huntsman (perfect). From W. A. Huntsman, Lawson, Mo. Berries medium to large; conical, almost spherical; deeply pitted; color dark glossy crimson; quite acid and rather soft; plants vigorous, free from disease and moderately prolific. Probably too soft for long shipments, but for near markets and for home use it may be ranked as promising.

Ivanhoe (perfect). Berries medium, but uniform in size and regular in outline; conical; color bright glossy red; quality good; plants healthy, moderately vigorous and fairly productive. An excellent variety in most respects, the only weak point found in it is its similarity to Bubach and Muskingum in being rather difficult to start, often resulting in vacancies in the rows. It is more particularly an amateur than a commercial variety.

Jay Gould (imperfect). Plants are vigorous and healthy, but only moderately prolific. The berries average too small in size to constitute a profitable market variety. It ripens about the same time as the Crescent or a few days later than has been claimed. It can hardly find a place among standard varieties.

Lanah (perfect). From S. F. Brewer, St. Louis, Mo. Berries medium size; conical; bright red; quite firm; plants vigorous, but only moderately prolific. For shipping this variety may have some merit, but in most markets it would be rated as too small. For near market it could hardly take rank with such sorts as Greenville and Haverland. More properly it should be compared with perfect flowered sorts, such as Muskingum and Enhance, to which it is inferior both as to size and productiveness.

Leader (perfect). Berries above medium size, quite attractive in appearance and of good quality. A very good variety for home use and would probably prove profitable for market, although it is excelled in many respects by many other varieties.

Lovett (perfect). This is now well known and quite generally recognized as a valuable market variety to plant with the Haverland and Crescent. It is quite early, although not among the earliest, and continues a long time in bearing. It is one of the most prolific of the perfect flowered sorts and can be recommended as worthy of general trial. Its strongest competitor is the Cyclone.

Leviathan (perfect). From Henry G. Wolfgang, Leetonia, Ohio. Berries large; light red, glossy; usually flattened and wedged shaped; quality good; rather soft; season late; plants vigorous and quite prolific.

This is one of the most prolific of the late ripening sorts, and would rank high as a market variety, had it sufficient firmness and better color. For home use it would serve admirably.

Michel's Early (perfect). Too soft, small and unprolific for general purposes. In some sections it may prove profitable for market because of its earliness, and for home use it may serve to a limited extent, but its field of usefulness is very limited.

Muskingum (perfect). Quite vigorous in growth and yet the plants are rather difficult to start, and in consequence the variety is somewhat disappointing. Under favorable conditions it makes plants freely, and produces good crops of large, beautiful berries, but occasions are not rare when the stand of plants is very poor, and the crop light. It is rather late in beginning to ripen, and matures the bulk of its crop late, hence it must be classed among late varieties, and of these it is one of the most prolific. For home use it is unexcelled, and it is one of the most profitable of its class for market, when properly treated. It is a good variety to plant with Bubach and Greenville.

Meek's Early (imperfect). Plants very vigorous but unproductive. About as early as Michel's Early and even less prolific. Nothing favorable can be said concerning it.

Marshall (perfect). Large and beautiful in both form and color; plants vigorous and comparatively healthy, occasionally showing some signs of rust, but not enough to do any harm. The only doubt as to the Marshall is as to its prolificacy. The indications are that it is not as prolific as desirable, nor do the berries hold up as well toward the end of the season as could be wished. Two or three of the first pickings are very fine, but after that the berries run down in size rapidly, particularly in dry weather. For the commercial grower, to whom quantity is the first consideration, it will perhaps prove less profitable than the ordinary varieties, and the same is true in a measure of those who sell in the ordinary market. For market purposes it will probably prove entirely profitable only to those who cater to a fancy trade. Amateurs will be pleased with it, and the majority of those who grow berries for home use will find it satisfactory. No doubt it has a place but it will hardly supersede the standard sorts.

Maple City (perfect). From Boswell Fox, Winchester, Ky. A late variety, resembling Mt. Vernon in both foliage and fruit. Should it prove to be distinct it will be an acquisition among late sorts.

Princess (imperfect). Berries medium to large, quite uniform in size and regular in form, presenting a fine appearance; plants vigorous, healthy and productive. Possibly too soft for long shipment, but excellent for near market and home use. On the whole a promising variety and worthy of general trial.

Portage (perfect). From M. O. Hall, Freedom Station, O. Berries large; cockscombed; similar in shape to the Sharpless, but without the green tips; plants vigorous and quite prolific. Should this variety prove to be sufficiently productive it will be an acquisition.

Parker Earle (perfect) One of the most prolific of varieties. The plants are vigorous, throw out but few runners, and set an enormous crop of berries. Under favorable conditions the berries are medium to large, but ordinarily only a few of the first attain marketable size. It cannot be grown satisfactorily except on a very rich soil and with an abundance of moisture.

Princeton Chief (imperfect). Berries medium size, conical; often slightly ribbed but usually quite uniform in size and regular in form; bright red and attractive in appearance; firm; very acid; plants vigorous and healthy, but only moderately prolific. This variety has some merit as a shipper, but for near market it can hardly compete with Haverland, Warfield and Greenville, as these all rank above it in productiveness. It is late in ripening which may enhance its value in some cases. It is somewhat like the Ohio, but of better color, and like that variety will probably not prove popular with growers, and still less so with those who plant for home use. It is worthy of trial, however, particularly for shipping. It has been on trial here but one season, and further test may show that it is more prolific than it was last season.

Regina (imperfect). So very unproductive as to be of little value.

Riehl's No. 6 (perfect). From E. A. Reihl, Alton, Ill. Berries medium to large; conical; dark red; plants medium as to vigor; somewhat subject to rust; productive. The berries hold up in size quite well to the end of the season. A promising variety, except as to apparent weakness of the plants, which might not work injury in favorable seasons. Tested only one season.

Robinson (perfect). From B. F. Smith, Lawrence, Kan. Berries medium size; conical, often flattened; deeply pitted; dark glossy red; quite acid; plants somewhat subject to rust; moderately prolific. Not promising.

Smith's 77 (perfect). From B. F. Smith, Lawrence, Kan. Berries medium to large at first but run small toward the last of the season; conical, but often flattened and double; bright red and glossy; quite acid; plants vigorous and prolific. May be ranked as promising, its greatest fault being its tendency to fall off in size toward the end of the season. It would answer well to pollenize the Crescent or Haverland.

Southard (perfect). Plants subject to rust and unproductive. Not desirable.

Standard (perfect). Resembles Michel's Early closely, at least no better.

Smeltzer's Early (perfect). From Frank H. Smeltzer, Van Buren, Ark. Berries small to medium, but uniform in size; bright and attractive; firm; quality medium; plants vigorous and quite prolific. The greatest merit of this variety seems to be its shipping qualities. It can hardly be classed as early, ripening with the Crescent. It does not furnish a plentiful supply of pollen, hence cannot be recommended as a pollenizer.

Swindle (imperfect). This variety has been on trial for several seasons but is so subject to rust that it has never given a satisfactory crop, although in some seasons it has given moderate crops of very sour berries. It is generally discarded by practical growers.

Saunders' Success (perfect). From A. Saunders, Sac City, Iowa. Resembles the Downing closely, both in fruit and foliage. It is not more prolific than that variety, but the plants are more vigorous and less liable to disease, while the berries are slightly larger. It may succeed more generally than the Downing, because of better foliage, although it is not wholly free from rust. Because of good quality it will be excellent for home use, and possibly prove profitable for near market.

Shuckless (perfect). Fruited on fall set plants only, hence not fully tested. Berries medium size; quite uniform and regular, resembling the old Green Prolific somewhat. Although the berries part from the calyx readily a core usually comes with the calyx, which injures the keeping qualities of the berries and makes them unsightly. Commercial growers will be slow to see the value of the shuckles habit, but for private gardens it may, by some, be regarded as a virtue. It may prove to be prolific enough for market purposes but it is probable that most growers will prefer to have the berries picked with the calyx on.

Timbrell (imperfect). Berries medium to large; quite uniform in size and regular in shape; color an indescribable patchy appearance, which is far from pleasing. Occasionally a berry is well colored, but the majority are white on one side with patches of different shades here and there over the upper side. From 50 plants not a single quart of well colored, marketable berries, were picked during the season. The greater share were unmarketable, because of the unripe and dingy appearance. The dry weather near the close of the season may have caused the above mentioned lack of coloring, but the same effect was not apparent with other late sorts. The quality is excellent, even of berries that do not appear to be ripe. It is probably more prolific than any other late variety, and could be rated as an acquisition if not for the fault named.

For home use this defect is not much against it, and no doubt in some soils and in favorable seasons it will not appear in so marked a manner.

The grower for market who has the experience above recorded will be slow in giving the Timbrell a place the second time. Reports regarding it do not agree; some speaking favorably of it, others condemning it. In general it is safer to let varieties alone that exhibit marked defects, for it shows them to be unreliable, but the Timbrell has so many good qualities that it deserves a thorough trial.

Tucker (perfect). From Isaac Classon, Osage, Iowa. Berries of medium size; conical; bright glossy red; plants lacking in vigor and subject to rust. Not promising.

VanDeman (perfect). Berries firm and of good color, but too small to meet the demands of most markets. It has met with little favor from growers generally, although a few esteem it highly.

Warfield (imperfect). This is now regarded as one of the most valuable varieties of its class. Its firmness makes it valuable for shipping and canning. If grown in matted rows too many plants should not be allowed to set, as in such a case it is liable to suffer from drought. It seems to be more sensitive in this particular than Haverland and Crescent. Brandywine and Enhance are suitable varieties to plant with it, as they are both firm and similar to it in color.

Williams (perfect). Plants weak and subject to rust. Not desirable for this reason, although the berries are fine in appearance and of good quality.

West Lawn (imperfect). From C. F. Bauer, Judsonia, Ark. Berries medium to large; conical; dark red; plants healthy and moderately productive. The berries hold up in size quite well to the end of the season. A promising variety, the only doubt being as to its productiveness. It is said to do better the second than the first year, which is often the case with moderately prolific varieties.

Woolverton (perfect). Plants healthy but not very vigorous, and only moderately prolific; berries medium to large, and hold up well in size until the end of the season. As a pollenizer it can be recommended, although it has no special merit not possessed by many other varieties.

Unnamed variety (perfect). From S. H. Boner. Resembles the Sharpless in both plant and fruit, and has the same fault of not coloring at the tips. It has some promise as a late variety, probably being later than the Sharpless.

Unnamed variety (perfect). From S. Buffington, Kessler, O. Berries medium to large; conical; bright red; quality good; plants vigorous and fairly prolific. Probably lacks in productiveness, but valuable in other respects.

Unnamed variety (perfect). From Clark Hewitt, Waupun, Wis. Berries medium to large; usually conical but often flattened; bright red and glossy; quite firm; plants moderately vigorous, healthy and quite prolific. Promising.

Unnamed variety. From Clapp & Ray, East Claridon, O. Berries medium size; conical; dark red; rather acid; plants not strong and subject to rust. Plants did not make sufficient growth the season previous to give a conclusive test, but it is probable that they lack vigor.

Unnamed variety (imperfect). From G. Swably, Tiffin, O. Plants quite vigorous, but somewhat subject to rust. Berries too small for market. Not promising.

Unnamed variety (perfect). From J. W. Hall, Marion Station, Md. Berries medium, but uniform in size and hold up well to the end of the season; conical; dark red; rather acid and soft; plants vigorous and quite prolific. For near market this is quite a promising variety. Although somewhat lacking in size the berries are uniform throughout the season, which is a redeeming quality.

Unnamed variety (perfect). From A. Luther, Leeds, Mo. Berries medium throughout the season, holding up well to the last; conical; dark red; plants vigorous and quite prolific, but somewhat subject to rust. Quite promising as an early market variety, ripening a few days after Michel's Early, and producing much more heavily. Although quite small its uniformity in size redeems it.

Unnamed No. 1 (perfect). From H. S. & A. J. Lee, Geneva, Pa. Berries rather below medium size, but quite uniform; conical; dark red plants vigorous and productive. Ripens at about the same time as Michel's Early, and is much more prolific. It could be ranked as a very promising early variety if the berries were a little larger, but for some markets this would not impair its value greatly. Except in the matter of size this is the most promising of the very early sorts.

Unnamed No. 2 (imperfect). From H. S. & A. J. Lee, Geneva, Pa. Berries medium size at first, but small toward the last of the season; conical, rather long; dark red glossy; plants healthy and productive; Promising except in the particular noted.

Unnamed variety (perfect). From Wm. Mendenhall, Marion, Ind. Berries medium to large; conical; light red; rather soft; plants vigorous but somewhat subject to rust. A promising variety for home use but too soft and light colored for market.

SUMMARY.

1. Strawberries do well on almost any well drained soil, which is free from frost, reasonably fertile, and not infested with white grubs.

2. There is little danger of making the soil too rich, but there is a possibility of injuring the plants with commercial fertilizers, if placed too closely about the roots, and with coarse manure.

3. Commercial fertilizers seem to have no effect on white grubs, nor does manure, but the latter stimulates the plants, so as to repair the damage.

4. The best fertilizers are well rotted manure, bone meal and wood ashes.

5. The best method of preparing the soil is to plow in the fall, mulch with manure, and fit the ground in the spring with cultivator and harrow.

6. The best time to set strawberry plants is in early spring. When plants are to be set in the fall they should be especially grown for the purpose, either in frames or in pots.

7. For matted rows the plants should be set 18 inches by four feet apart, and for hills, one foot by three.

8. In hill culture the runners are all removed, and for the best results in matted rows a part should be cut off, or some of the plants dug out.

9. Generally, it is better to keep a bed only one season, but if kept longer the best treatment is burning soon after fruiting.

10. Winter protection should be given by mulching, and the best material is swamp hay.

11. It is not advisable to remove the mulch in the spring, either to cultivate or to avoid frost, unless the soil is very weedy.

12. The largest per cent of good seedlings has been from crosses of the best varieties, and the smallest from seeds gathered at random.

13. A good rule in selecting varieties is to take only those that have shown the best results in many different sections, rejecting those that appear to be variable, and have exhibited weaknesses elsewhere.

14. The following are the most promising of the new varieties: Aroma, Belt's No. 3, Brandywine, Brunette, Cyclone, Granville, Huntsman, Ivanhoe, Leader, Leviathan, Marshall, Princess, Portage, Princeton Chief, Riehl's No. 6, West Lawn, Woolverton.

15. The following are doubtful: Auburn, Beverly, Banquet, Epping, Early Bird, Gov. Hoard, Jay Gould, Lanah, Maple City, Robinson, Southard, Smeltzer's Early, Swindle, Shuckless, Timbrell, Tucker, Williams.

16. The following are poor: Eclipse, Gillespie, Michel's Early, Meek's Early, Regina.

17. The following are the best of those that have been thoroughly tested and are the cream of the list: Bubach, Crescent, Enhance, Greenville, Haverland, Lovett, Muskingum, Parker Earle, Warfield.

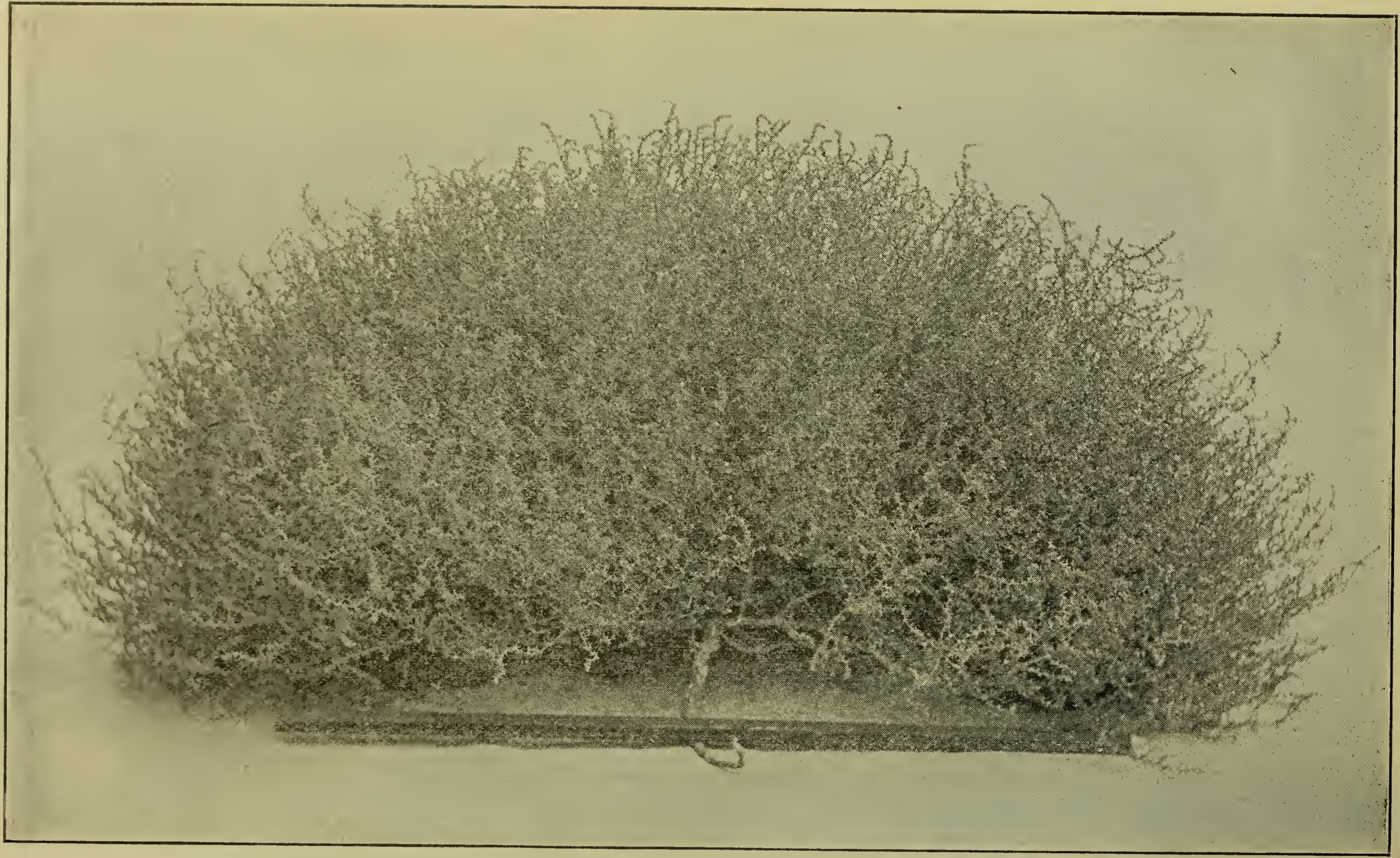

PLATE I.

COMPACT FORM OF RUSSIAN THISTLE.

From a photograph of plant found near Bryan, O., along tracks of Lake Shore and Michigan Southern Railway, September, 1894.

BULLETIN

OF THE

Ohio Agricultural Experiment Station.

NUMBER 55. OCTOBER, 1894.

THE RUSSIAN THISTLE IN OHIO.

BY AUGUSTINE D. SELBY, B. SC., BOTANIST.

A new and pernicious weed has just entered the State from the westward. In view of what this weed has done elsewhere and gives promise of doing in Ohio, for citizens of the State and all owners and occupiers of land to fail in applying prompt and effective remedies, would be shortsighted and unwise. To the end that the pest may be recognized and every available measure applied for its eradication wherever it appears, this bulletin is devoted almost exclusively to it. The Russian thistle is known at present to exist in but one county, and only to a limited extent in that, but from the manner of its introduction, promptness in dealing with it seems very desirable.

The descriptive and general matter of this bulletin lays no claim to originality, other publications having provided the original sources of information concerning the plant. Special mention should be made, at the outset, of the bulletins on the Russian thistle, by Lyster H. Dewey, of the U. S. Department of Agriculture, Washington.

NAME OF THE PLANT.

This plant is called Russian thistle, Russian tumbleweed and Russian cactus. It is really neither a thistle nor a cactus, but is properly a tumbleweed and related to other plants known by that name. The name Stalwort was usually applied to the plant before its spread in the west. The name Russian thistle seems most generally used and is therefore employed here. To botanists the plant is known as *Salsola kali tragus* (L.) Moq., of the natural order Chenopodiaceæ. The common goosefoot or lamb's quarters belongs to the same order, and the tumbleweed, *Amarantus albus*, to a closely allied order.

DESCRIPTIONS.

The Russian thistle is an annual plant, coming from seed every year, 1 to 3 feet in height, branching profusely from the base, forming a low spreading growth varying in density as shown in Plates I and II, and from a few inches to 6 feet in diameter. The color of the whole is light green; the stem, branches and upper leaves are striped with longitudinal red lines. The root is distinctly a white tap root with few branches and easily pulled from the ground. The leaves are alternate on the stem; those of the young plant are single, 1 to $1\frac{1}{2}$ inches long, very narrow, (about $\frac{1}{8}$ inch) rather thick, soft and yielding, but with a spine-point, dropping off more or less (see Plate III, Fig. *b*). The leaves of the mature plant, especially on the upper branches, are in threes, two bracts diverging from above the base of each leaf, short, $\frac{3}{8}$ to $\frac{1}{2}$ inch long, rigid, fleshy, with broad thick base, tapering rapidly to a spiny point, making a cluster of stiff spines (see Plate III, Fig. *a*). Flowers from July to October, solitary and without stalk, one above the base of each cluster of spines, about $\frac{3}{8}$ inch in diameter, bright rose color to pale white, thin and papery, with five divisions to the calyx, stamens 5 and styles 2 (see Figs. *c* and *d*, Plate III); seed attached to the base of each flower, $\frac{1}{16}$ inch in diameter, at the top, much broader than at the bottom, of coiled appearance (Fig. *e*). Embryo green in color and spirally coiled (Fig *f*). Seeds mature from late in August to October and possibly November. With winter, the plants break off at the surface of the ground, and are rolled by the wind, scattering the seed.

The following technical description is taken from bulletin 15, Division of Botany, U. S. Department of Agriculture, by L. H. Dewey:

> "*Salsola kali tragus* (L.) Moq. in DC. Prod., XIII, 2, 187 (1849). A herbaceous annual, diffusely branching from the base, $1\frac{1}{2}$ to 3 feet (0.5 to 1 m.) high and twice as broad, smooth or slightly puberulent; tap root dull white, slightly twisted near the crown; leaves alternate, sessile; those of the young plant deciduous, succulent, linear or subterete 1 to 2 inches (3 to 6 cm.) long, spine-pointed, with narrow, denticulate, membranaceous margins near the base; leaves of the mature plant persistent, each subtending two leaf-like bracts and a flower at intervals of $\frac{1}{12}$ to $\frac{5}{12}$ of an inch (2 to 10mm.), rigid, narrowly ovate, often denticulate near the base, spine-pointed, usually striped with red like the branches, $\frac{3}{12}$ to $\frac{5}{12}$ of an inch (6 to 10 mm.) long; bracts divergent, like the leaves of the mature plant in size and form; flowers solitary and sessile, perfect, apetalous about $\frac{5}{12}$ of an inch (10 mm.) in diameter; calyx membranaceous, persistent, inclosing the depressed fruit, usually rose colored, gamosepalous, cleft nearly to the base into five unequal divisions about $\frac{1}{6}$ of an inch (4 mm) long, the upper one broadest, bearing on each margin near the base a minute tuft of very slender coiled hairs, the two nearest the subtending leaf next in size, and the lateral ones narrow, each with a beak-like connivent apex, and bearing midway on the back a membranaceous, striate, erose-margined horizontal wing $\frac{1}{12}$ of an inch (2 mm.) long, the upper and two lower wings much broader than the lateral ones; stamens 5 about equaling the calyx lobes; pistil simple; styles 2 slender about $\frac{1}{25}$ of an inch (1 mm.) long; seed 1 obconical, depressed, $\frac{1}{16}$ of an inch (nearly 2 mm.) in diameter, dull gray or green, exalbuminous, the thin seed-coat closely covering the spirally coiled embryo; embryo green, slender, about $\frac{1}{2}$ inch (12 mm.) long when uncoiled, with two linear cotyledons. The plant flowers in July or August, and the seeds mature in September and October. At maturity, the action of the wind causes the root to break with a somewhat spiral fracture at the surface of the frozen ground, and the plant is blown

about as a tumbleweed. The mature flower with the inclosed seed is held in place by the minute tufts of coiled hairs, preventing the seeds from falling all at once when the plant begins to roll."

CONCERNING SEEDS AND RESEMBLANCES.

A plant like that shown in Plate I, frontispiece, will produce from 100,000 to 200,000 or more seeds, enough to seed a large tract effectually. A small plant relatively, will ripen many thousand seeds.

Too much importance can scarcely be attached therefore, to the matter of recognizing seeds of the Russian thistle. Flax seed and millet seed, possibly clover seed also, may contain the seeds of this weed as an impurity, particularly if obtained from infested regions. Scan your seeds closely for several years to come!

A word about resemblances will be of possible help. A large number of specimens of tumbleweed, *Amarantus albus*, L. have been sent to the Station for the Russian thistle. Many of the specimens had the same habit of growth as the true Russian thistle, but are distinguished by the absence of spine-points on all leaves and by the presence of broad flat leaves. The seeds of the tumbleweed are round and shining with one diameter much shorter than the other.

ORIGIN, HISTORY AND INTRODUCTION.

The Saltwort has been known on the shores of Europe, Asia and America for more than a century, that is the *Salsola kali* L. "The variety *tragus* Moq.," states Mr. Dewey, "seems to have developed on the plains of southeastern Russia where the conditions are very similar to those of the great plains region of the United States." "For many years it has been a destructive weed in the barley, wheat and flax regions of southeastern Russia, and the cultivation of crops has been abandoned over large areas of some of the provinces near the Caspian Sea."

It appears that the plant was first introduced into the United States in 1873 or 1874, in flax seed brought from Russia and sown near Scotland, Bonhomme county, S. Dakota. Thence it has spread until at present it involves large parts of North Dakota, South Dakota and Nebraska, with frequent occurrence in Minnesota, Wisconsin, Iowa, Kansas and Colorado. During the summer of 1894 it has been reported from Canada, Idaho, Illinois, Michigan, Indiana and Ohio, with other localities no doubt not known to the writer. The spread of this weed has been so rapid that it may be expected to invade Ohio with great strides; not sweeping every point, but finding a foothold here and there as the seed may be brought in. The only locality from which the true Russian thistle has as yet been reported in Ohio is in the vicinity of Bryan, Williams county; specimens were sent in from that point August 30, by Geo. W. Myers. Personal examination afterwards made, disclosed its presence for about eight miles along the L. S. & M. S. Railway. The plant photographed for

Plate III grew about six miles east of Bryan, and was pulled up two or three days before it was photographed. The yard stick in the foreground shows the spread of this plant, nearly five feet. Clearly the plants were introduced near Bryan by the railroad, probably by litter from stock cars loaded in the northwest and west. Seeds could easily be jarred out by the moving train or kicked out by the stock. Old plants found by Mr. Myers show that seeds were matured near the infested point last year (1893).

THE LIMITED AREA COVERED NO INDEX OF THE IMPORTANCE OF ACTION.

That an ordinary weed had been found in a single county of the State may seem of small importance, yet not so with the Russian thistle. As is shown from foregoing statements, sufficiently corroborated, the plant may now be ready at many other points to scatter seed. Every railroad traversing the State and handling cars loaded with stock in the infested regions is a possible source for introducing this weed. In a greater measure are the east and west trunk lines liable to bring the pest. It is hoped that timely warning and directions may prevent the weed from gaining such a foothold as in states farther west. The occurrence at all in Ohio should enable us to know the reality of the danger

MANNER OF DISSEMINATION.

In the fenceless prairies the Russian thistle rolls as a tumbleweed and thus travels over considerable distances, depositing the seeds. (Note office of hairs in holding seeds, see page 58.) For Ohio this method of scattering the seed promises to play a subsidiary though by no means an unimportant part. We note that the weed will be introduced almost entirely in two ways:

First—By the railways and along their lines.

Second—In impure seeds and forage, such as hay from the regions where it is found.

The spreading from a given point where it may secure a start, will be aided through the rolling habit; but if the beginning be along a railway the work of the wind can scarcely carry the seeds off the right of way of the railroad. On the other hand, a few plants in a large inclosure may sow enough seeds to give great trouble; in like manner this scattering will occur along railroads between the fences at cattle guards, etc.

The railroads may properly be appealed to, to destroy the thistles along their lines. The farmers are to be warned against using any seeds or forage containing seeds of the Russian thistle.

WHAT PROMISES TO BE THE CHARACTER OF THE RUSSIAN THISTLE IN OHIO?

There is little room for consolation so far as may be inferred from present conditions. For the United States, the spread of the Russian thistle through what we may call involuntary agencies has equaled, if it has not surpassed, the spread of any plant disseminated voluntarily. In character the plant is one of the worst weeds. It intrudes where not wanted, and the damage in the wheat growing regions of the Dakotas has been very great. There are plenty of neglected places in Ohio, and some not so classed, that will produce many fold of these pests. It may be found, if once well spread, which let us hope may not happen, that these plants will grow as do the Amarantus, Chenopodium, and smartweed in corn and potato fields that have been laid by. In these places it would be troublesome as well as in the wheat to follow. Neither may we take the view that it is likely to die out of its own accord. This appears to be wholly untenable.

Taken altogether, the only feasible plan appears to be that of a war of extermination. This extermination is possible now.

PUBLICATIONS CONCERNING THE RUSSIAN THISTLE.

The following publications concerning the Russian thistle are mentioned since some of them may be available in certain cases:

Farmer's Bulletin No. 10, U. S. Department of Agriculture, by L. H. Dewey (issued January, 1893). Bulletin Wisconsin Experiment Station No. 37, by E. S. Goff (October, 1893); Nebraska Agricultural Experiment Station, Bulletin No. 31, by Chas. E. Bessey (December, 1893); Bulletin No 15, Division of Botany, U. S. Department of Agriculture, by L. H. Dewey (May, 1894).

An illustrated poster supplement is issued with this bulletin and is especially designed for use by section foremen and in post offices and public places. Almost every important agricultural paper has published one or more references to the Russian thistle, and in many cases illustrations also.

REMEDIES AND SUGGESTIONS.

I. These are all summed up together in the following statements:
  1. No Russian thistles are to be allowed to go to seed.
  2. All that escape destruction before ripening seeds are to be destroyed by fire.
  3. See that all seeds and forage used are free from seeds of Russian thistle; flaxseed and millet seed should receive special examination.

II. How may the results aimed at in I, be attained?

It is to be noted that the plant is an annual and that the seeds have a probable low vitality. The labor of eradication is thereby reduced; it must rely for its efficiency on the destruction of the seeds. Young plants may be pulled up or larger ones before August 20. This will suffice; cutting is not final as the plants sprout up again. After the date above given, all plants should be first pulled up and after drying, thoroughly burned. Unless a brush pile or log heap is at hand, the green plants will be found too succulent to burn well.

III. The modification of our weed laws may prove of service. However, there is danger in relying on the laws to eradicate weeds. The laws are valueless unless every one does his whole duty and sees to it that his neighbor, his road supervisor, and his railways do the same. Roadsides should not be allowed to harbor weeds of any kind. The law is very explicit as to who shall destroy them.

IV. This bulletin is issued in the belief that it will prove of use during several seasons. The Russian thistle is likely to come into certain localities, then into others, and still others. Preserve this bulletin for future use.

DESCRIPTION OF PLATES.

Plate I. Frontispiece, shows the compact form of Russian thistle, Ohio specimen, much reduced in size. The engraving is from a photograph by Beach, of Bryan, Ohio,. The measure in the foreground is a yard-stick. The plant grew about six miles east of Bryan, along the L. S. & M. S. railway.

Plate II. Shows the ordinary form of Russian thistle, more open than the preceding. We are indebted to the U. S. Department of Agriculture for the cut.

Plate III. This cut also was obtained through the courtesy of the Department of Agriculture, Washington. It shows at Fig. *a* branch of mature plant, natural size; *b*, seedling about two weeks after germination, natural size; *c*, flower detached from the axil and remaining suspended by minute hairs in the ordinary inverted position on a rolling plant, enlarged three diameters; *d*, flower viewed from above and in front, showing the calyx, lobes, etc., enlarged three diameters; *e*, seed with flower parts removed from the seed, enlarged five diameters; *f*, embryo removed from the seed, enlarged seven diameters.

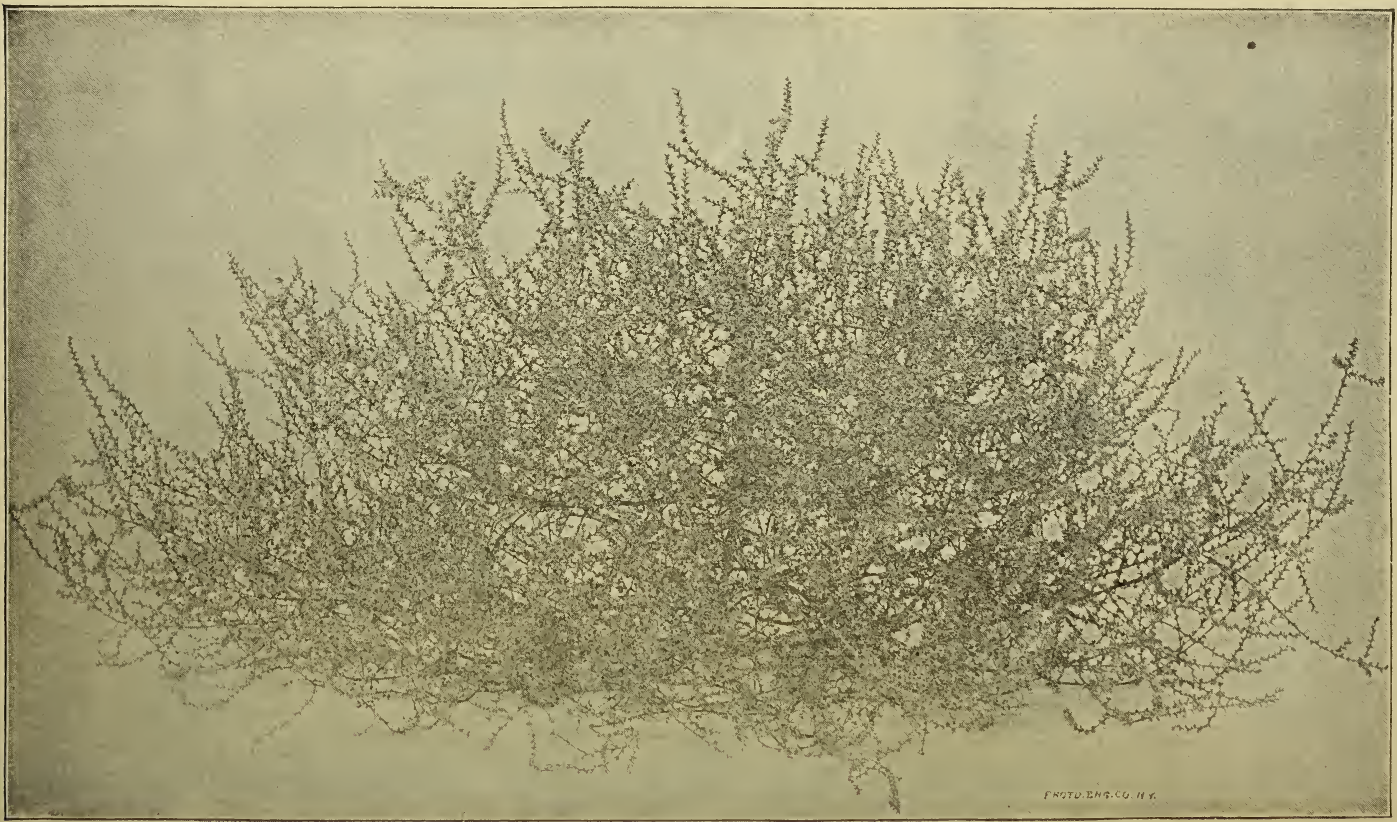

PLATE II.

RUSSIAN THISTLE—ORDINARY FORM.

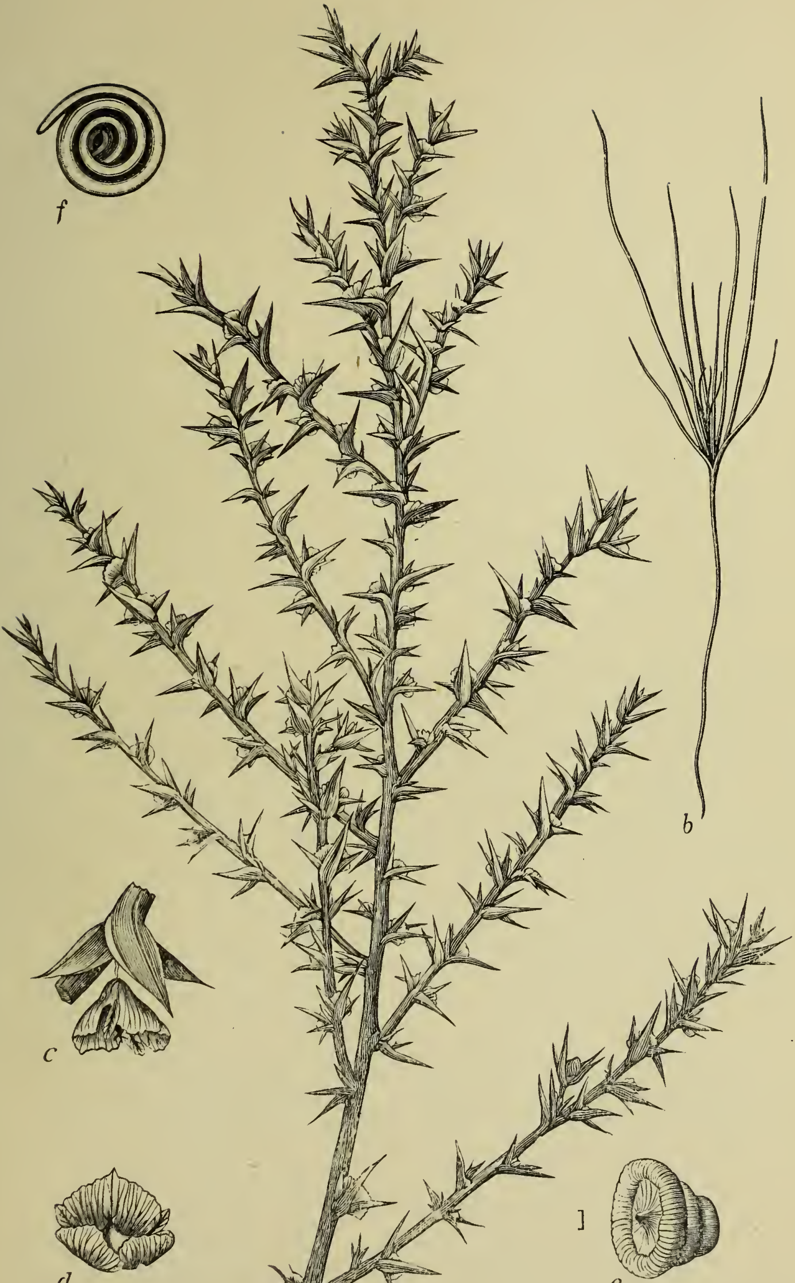

PLATE III.

RUSSIAN THISTLE—Detailed Figures.

WEEDS IN GENERAL.

WHAT IS A WEED AND HOW DO WEEDS DIFFER?

A weed is a plant out of place; one that tends to invade places where it is not wanted. The difference between the Russian thistle and other weeds is one of degree rather than of kind. Canada thistle and horse nettle, where these are well started, would be rather more difficult, perhaps, than the Russian thistle to eradicate. This is due to the greater ease with which an annual weed is destroyed than is a perennial one whose roots or underground parts survive from year to year. In the case of one coming from seed every year i. e., an annual, the prevention of a crop of seed limits the spread of the plant; in such cases one must not overlook the presence of a supply of seeds in the soil capable of germination later, provided the plants have been permitted to ripen seeds in the past. Take an illustration from the lamb's quarters and pigweeds that grow in the early potato field or garden, or even in corn; one year's clean culture will not free the soil from the weeds. The period during which clean culture must be practiced will depend upon the vitality of the seeds in the presence of moisture. The Russian thistle is a plant whose seed vitality is thought to be rather low; the ragweed enjoys a reputation quite the contrary.

In the class of perennials we note important differences dependent upon another feature, namely: The presence or absence of creeping rootstocks. The mints, Canada thistle, horse nettle and some others, have these creeping underground stems, by which the plant encroaches more and more each season upon the surrounding area, involving an ever widening circle. Not only these spread by under ground parts, but there is the spread by seed in addition. The worst is really only understood when we undertake to dig up and exterminate a weed like Canada thistle or mint; if a piece of the rootstock remains, then a new plant appears; the breaking or cutting of the rootstock may indeed only increase the pest. In case of many perennial plants a single digging ends the nuisance.

The class of biennial weeds includes those growing from seed one season but not blossoming nor producing seeds until the following summer. The common thistle, winter cress and in part the prickly lettuce belong here.

ONE CLASSIFICATION OF WEEDS.

We may classify our weeds then in the following manner:

I. Annuals, i. e., growing from seed every year and dying after ripening seed: Russian thistle, pigweed, lamb's-quarters, ragweed, smartweed, foxtail, crabgrass and frequently prickly lettuce.

II. Biennials, i. e., growing from seed but not producing seed until the second season: Wild parsnip, wild carrot, common thistle, winter cress, the mulleins, burdock and often the prickly lettuce.

III. Perennials, i. e., plants surviving year after year by underground parts, also propagated from seeds. Of these we have two classes:

A. Such as have underground, creeping rootstocks—Horse nettle, Canada thistle and mint.

B. Those without horizontal rootstocks—Oxeye daisy, asters, golden-rods, agrimony, narrow leaved plaintain, broad leaved plaintain.

A study of the root systems of our worst weeds will give valuable data. The classes "annual," "biennial" and "perennial" are arbitrary, and plants under all conditions do not conform to any one class. Prickly lettuce may be both annual and biennial, and narrow leaved plaintain may be either biennial or perennial.

Use such a table and classify the weeds on your farm; you will be surprised at the questions it presents to you. Not the least important one is this, "How shall each weed be exterminated?"

Obviously the measures taken must be in accordance with the facts of the plant's life history. Always wage a winning warfare if possible, and a warfare against weeds is bound to be a winning and profitable one in the end, if undertaken with this knowledge.

ANOTHER WAY OF CLASSIFYING WEEDS.

This is according to the means of their dissemination. Some have such a ready means of scattering the seed that the entire country is soon overrun. The prickly lettuce (*Lactuca scariola*) is a good illustration. Appearing in Ohio in 1878 and 1879, it has now scattered over the whole State, by reason of the buoyancy of the seed and its tuft of attached hair (pappus). The thistles are disseminated in the same way. Many plants are started from seeds dropped off cars or wagons; still others are distributed in seeds. The stick-tights, beggar's lice and hound's tongue attach themselves to animals. Very few weeds are scattered by having edible berries.

Still another way is to put the weeds of farm and garden into classes such as "worst weeds," "bad weeds," "indifferent weeds." Which are the ten worst weeds in your locality?

WEEDS COMMONLY FOUND IN GRASS AND OTHER SEEDS.

Some very bad weeds are introduced and disseminated in this manner. Canada thistle, the Russian thistle, horse nettle, smartweeds, the plaintains, wild carrot, the weedy grasses, such as crab grass, panic grass and others. Millet seed and clover seed are especially prone to contain impurities of the sorts named. Some specimens examined in the past had a half dozen or more different kinds of weed seeds in a small sample Be careful to sow no impure seeds!

WEEDS ALONG HIGHWAYS AND RAILROADS.

These are a constant source of irritation and of danger. The weeds should be cut by the proper authorities. It should be carefully observed whether this is done upon the right of way along railroads and highways. In the case of highways it is made a certain officer's duty by statute and the interests of all demand the performance of this duty.

Finally, it may be stated that the botanist of this Station purposes to prepare a more or less extended account of the weeds of the State, with illustrations so far as practicable. This must be left till another season at earliest; meanwhile correspondence and specimens with information will receive careful attention.

OHIO WEED LAW.

The following is the Ohio statute pertaining to the destruction of weeds, as amended and passed April 25, 1893. (Ohio Laws vol. 90, p. 301.)

SECTION 4730. The superintendent of any improved or macadamized road, supervisor of county and township roads, or street commissioner of any city or village, shall, between the 15th and 30th days of June, and between the 1st and 15th days of August, and between the 15th and 30th days of September of each year, cut all brush, briers, Canada or common thistles, or other noxious weeds growing within the limits of any county or township road, improved or macadamized road, street or alley, within their jurisdiction. Such superintendent or supervisor shall be allowed $1. 50 per day for all necessary labor, to be allowed by the trustees and paid by the treasurer of such township out of the road fund then in his hands. The superintendent or supervisor of any such roads may allow any landowner or tenant to cut and destroy any such brush, briers or weeds, growing on such highways, [along] the lands abutting on such highways owned or occupied by such landowner or tenant, and before such work is performed allow and fix a reasonable compensation therefor, which amount shall be credited on the road tax of that year assessed against said premises. The superintendent or manager of any toll road shall cut and destroy all brush, briers and noxious weeds growing within the limits of any such road, between the days of each month as above specified in this section, and in default thereof and for five days thereafter the trustees of any township through which any such road passes shall cause any such brush, briers and weeds to be cut and destroyed, and shall have right of action against any such toll road company, for the amount of such work, together with one hundred per cent. penalty, and cost of action to be recovered before any justice of the peace of such county.

SECTION 4732. The trustees of any township of this state, upon information in writing, that Canada or common thistles, oxeye daisy, wild parsnip, sweet clover, wild carrots, teasels, burdock or cockle burs, are growing on any lands in their township and are about to spread or mature seed, between the first day of June and the fifteenth day of October of each year, said trustees shall cause notice in writing to be served upon the owner, lessee, agent or tenant having charge of any such lands, notifying such owner, lessee or agent or tenant that Canada or common thistles or other noxious weeds mentioned in this section are growing on such lands, and that such Canada thistles or other noxious weeds shall be cut and destroyed within five days after the service of such notice; and in default thereof, that said township trustees will enter upon such lands and cut and destroy such Canada or common thistles or other noxious weeds; and that the cost of cutting such Canada or common thistles or other noxious weeds, with the cost of such notice, will become a lien against said lands. Any constable or deputy marshal of any city or village, or deputy, is hereby authorized to make service and return of any such notice, and the fees for such services and return shall be the same as are allowed for service and return of summons in civil cases before magistrates. If any owner, lessee, agent or tenant having charge of any such lands shall fail to comply with such notice, the township trustees shall cause said Canada or common thistles or other noxious weeds to be cut and destroyed, and may employ any person to perform such labor, and allow such person fifteen cents per hour for the time occupied in performing such labor, and pay the sum for such labor out of any money in the treasury of said township not otherwise appropriated, and take receipt for the same. Said township trustees shall make return in writing to the board of commissioners of their county, with a statement of the charges for their services, the amount paid to the person for performing such labor together with the fees of the officers who made the service of notice and return, with a proper description of the premises; and the same having been allowed, shall be entered upon the tax duplicate, and shall be a lien against said lands, from and after the date of such entry on the duplicate, and shall be collected as other taxes, and returned to the township with the general fund.

SECTION 4732*a*. That in all cities and incorporated villages, except cities of the first and second grade of the first class and first and second grade of the second class, the mayor shall, during the month of May of each year, cause notice to be published for two consecutive weeks in one or more newspapers published in the corporation, or by posting up written or printed notices in said city or village at three public places for ten days next previous to the first day of June of each year, warning the owners, lessees or agents of lots and lands within such city or village to cause all Canada or common thistles, or other noxious weeds mentioned in section forty-seven hundred and thirty-two, growing on any such lots or lands within said corporation, to be cut and destroyed so that they do not mature seed or spread to adjoining lands. The common council of such city or village shall, upon information in writing that Canada or common thistles or other noxious weeds mentioned in section forty-seven hundred and thirty-two are growing on any such lands, within their corporation, between the tenth day of June and the fifteenth day of October of each year, [shall] cause such Canada or common thistle or other noxious weeds to be cut and destroyed so that they do not mature seed or spread to other lands, and said council may employ any person to cut and destroy said noxious weeds and allow such person so employed fifteen cents per hour for the time employed in such labor. And said council shall pay said amount out of the money of the general fund in the treasury of said city or village not otherwise appropriated, and take a receipt therefor. And said council shall make return in writing to the board of commissioners of their county, with a statement of the amount paid for such labor, and one dollar additional, as a penalty on each lot or parcel of land containing less than one acre, and with two dollars on each lot or parcel containing more than one acre. The same having been allowed, the auditor shall enter the amount so certified to him on the tax duplicate of the county against the lots or lands on which said Canada or common thistles or other noxious weeds were cut and destroyed, and the amounts shall be a lien against said lots or lands from and after such entry, and shall be collected as other taxes are collected, and returned to such city or village with the general fund; provided, that [if] any such owner of such lots or lands shall tender to the treasurer of such township in cases of townships, or to the treasurer of such city or village in the case of city or village, the amounts so chargeable against such lots or lands for such labor, together with the penalty as certified to by the clerk of said township, city or village showing the amount of such charges and penalty, the treasurer shall receive the amount so tendered, upon which said lots and lands shall be discharged from further liability.

SECTION 4732*b*. Township trustees shall be entitled to $1.50 per day for their services under this act; the mayor of any city or village, or trustees of any township, or superintendent or other officer of any toll road, or superintendent of any improved or macadamized road, or supervisor of any county or township road, or street commissioner of any city or village, who neglects or refuses to perform their duties as mentioned in sections 4730, 4732 and 4732*a*, shall be fined in the sum of fifty dollars in any court having competent jurisdiction of such cases; such fines shall go into the road fund of the township in cases against township or toll road officers; and into the street fund in cases against mayors or other municipal officers.

SECTION 3. This act shall take effect and be in force on and after the first day of May, 1893.

The law pertaining to the destruction of weeds etc., along partition fences, passed April 29, 1885, is as follows: (Revised Statutes of Ohio (Giauque) vol. 1, pp. 1081–2):

To compel owners of land to keep brush, briers, thistles and other noxious weeds cut on their respective sides of line or partition fences.

SECTION 1. [4255–1.] *Be it enacted by the General Assembly of the State of Ohio,* That it shall be the duty of owners of land adjacent to any line or partition fence, when the enclosure of two or more persons is divided by such fence, and when the land is improved on both sides of the same, to keep all brush, briers, thistles or other noxious weeds cut in the fence corners, or along the line of partition fences; provided, however, that nothing in this section shall be construed to affect the planting of vines or trees for use.

SEC. 2. [4255–2]. If the owner or tenant occupying the same, neglects or refuses to cut, or have cut, such brush, briers, thistles, or other noxious weeds, as provided in the foregoing section, then any owner or occupant of land abutting on such line or partition fence, who may feel aggrieved thereby, may, after having given the owner or tenant occupying such land notice of his intentions, of not less than thirty days, (and if such brush, briers, thistles, or other noxious weeds are not cut or removed at the expiration of thirty days), notify the trustees of the township in which such land is situated, whose duty it shall be at once to repair upon the premises, when, if they become satisfied there is just cause of complaint, they shall proceed to cause such brush, briers, thistles, or other noxious weeds, to be cut in such manner as they may consider best, either by letting the work to the lowest bidder, or by entering into a private contract to have the same performed.

SEC. 3. [4255–3.] As soon as the work shall be completed to the satisfaction of the trustees, they shall certify to the auditor of the county the amount of the cost of such labor, together with the expense thereto attached with the correct description of the land upon which said labor has been performed, and the auditor shall place the same upon the duplicate, to be collected the same as other taxes are collected, and the county treasurer shall pay the amount when collected to the township treasurer as other funds, specifying the same.

SEC. 4. [4255–4.] The township trustees may anticipate the collection and refunding the cost of said labor to the township treasurer, and at the time said labor is performed draw their order upon such treasurer for amount, payable out of any township funds that may be in his hands.

SEC. 5. [4255–5.] The township trustees shall be entitled to one dollar per day for their services under this act.

The penalty for vending impure seed, amended February 14, 1884, is as follows: (Ohio Laws, vol. 81, p. 17, Giauque, vol. 11, p. 1725.)

SEC. 7001. Whoever knowingly vends any grass or other seed, in or among which there is any seed of the Canada thistle, white or yellow daisy, or wild carrot, and whoever being the owner, occupier or possessor of any land, suffers any Canada thistle, teasels or wild carrot to grow and ripen seed thereon, or on the highway adjoining the same, shall be fined twenty dollars.

Section 1 of the Wisconsin weed law says:

Every person and corporation shall destroy upon all lands which he or they shall occupy or control, all weeds known as Canada thistles, burdock, teasel, white-daisy and snap dragon, at such time and in such manner as shall effectually prevent them bearing seed. * * * *

A commissioner of Canada thistles is appointed and provision made for written notice, fine, etc.

Section 1 of the South Dakota weed law is as follows:

> Every person and every corporation shall destroy on all lands which he or it may own or occupy, all weeds of the kind known as Russian thistle, Canada thistle and cockle-burr at such time as the township board of supervisors, or the board of county commissioners, in counties which have not been organized into townships, may direct; and notice shall be published in one or more county papers for a time not less than three weeks before the time fixed upon for the destruction of said noxious weeds.

Overseers of highways are requested to destroy weeds in the same manner and upon vacant land or where the proper person fails to destroy them.

Reading these quotations from the Wisconsin and South Dakota laws in connection with section 4732 of Ohio statutes will suggest to many the question of the application of this section (4732) to the railways. The same question may arise in respect to the application of section 7001. I am not aware that this point has ever been passed upon by the courts. The statutes are very precise in making it the duty of road authorities to destroy noxious weeds along highways; at present the railroads are more careful to have weeds destroyed than are the authorities of highways.

The insertion of the names Russian thistle and horse nettle in sections 4730, 4732 and 7001 of Ohio laws, might cover a desired omission should the Russian thistle become at all general. The horse nettle is very abundant in many places in southeastern Ohio at present.

The recently enacted Ohio law concerning black-knot and peach-yellows is here appended as dealing with a kindred subject:

BLACK-KNOT—YELLOWS LAW.

AN ACT

To prevent the spread of the yellows, a contagious disease among peach, almond, apricot and nectarine trees, and to prevent the spread of the black-knot, a contagious disease among cherry, prune and plum trees, and to provide measures for the eradication of the same, and to repeal an act entitled "An act to amend section 1 of an act entitled 'An act to eradicate the disease known as black-knot on plum and cherry trees,'" passed April 13, 1893. (Ohio Laws, vol. 91, p. 108–13.)

SECTION 1. *Be it enacted by the General Assembly of the State of Ohio*, That it shall be unlawful for any person to keep, or to suffer or permit to be kept, or to remain upon his premises, or upon the premises under his charge or control, as owner or lessee, or otherwise, any peach, almond, apricot or nectarine tree infected with the contagious disease known as the yellows, or to keep any cherry, prune or plum tree infected with the contagious disease known as the black-knot, or any of the fruit from any of the said trees so infected, except from trees affected with black-knot, or to sell or to offer for sale, or to ship or permit to be shipped to any person in any manner, any of such fruit so infected, or from any trees so infected, except as aforesaid; that both trees and fruit so infected, except as aforesaid, shall be subject to destruction as public nuisances as hereinafter provided, and it shall be the duty of every person owning any fruit, or having in their charge or under their control any fruit from any of said trees so infected, or any of such fruit so infected, except as aforesaid, and of every person owning any of said fruit trees so infected, and of every person having any of said fruit trees so infected in their charge or under their control as agent, lessee or otherwise, to immediately destroy all such trees so infected and all of said fruit so infected, and all of said fruit from any tree or trees so infected, by burning the same; and whoever owning any of said fruit trees so infected, or any fruit so infected, or whoever having any of the same in charge as agent, servant or employe or lessee or otherwise, shall fail or neglect to destroy all of the same so infected within ten days after notice or knowledge of such infected condition, or shall fail or neglect to destroy all of the same within ten days after notice given to him by the township board of fruit commissioners, hereinafter mentioned, of such infected condition, shall be guilty of a misdemeanor and upon conviction shall be fined in any sum not exceeding one hundred dollars; provided, however, that in case of the black-knot in any such fruit tree it shall be sufficient to cut away and destroy only the limb or part of the tree affected with the black-knot, and destruction or the term destroy in this act shall be construed to mean destruction by fire.

SEC. 2. In any township in this state, on the application of not less than ten freeholders of said township, the township trustees of any such township may elect, others than those making the application as aforesaid, three competent freeholders of said township who are engaged in the business of growing any of such fruit, if such there be in the township; if there should not be three such persons within said township, then three persons, freeholders of said township, having experience or acquired knowledge in growing such fruit, as commissioners, who shall be known as the township board of fruit commissioners, each of whom shall hold office during the pleasure of the board of township trustees, and the order of election of said commissioners, and any order of their removal shall be entered upon the records of said township by the township clerk of said township; and each of said commissioners so elected, within ten days after their said election, shall file their acceptance of such appointment with said township clerk, and each of said commissioners, within ten days after their said appointment, shall give bond with not less than two sureties, to be approved by the township trustees, payable to the state of Ohio, in a sum not less than $200 nor more than $1,500, as may be directed by the trustees, conditioned for the faithful performance of their duties, which bond, with an oath of office of each commissioner in same form as required of a justice of the peace indorsed thereon, together with the approval of such bond by the trustees indorsed thereon, shall be filed with the township clerk. Each of said commissioners shall receive for each day necessarily engaged in the business of their said office, the sum of one dollar, and in addition they shall receive all of their necessary expenses incurred, all of which shall be allowed to them by the township trustees and paid out of the funds of said township.

SEC. 3. The township clerk shall be clerk ex-officio of said township board of fruit commissioners, and he shall keep a correct and complete record of all their proceedings in a book to be provided him by the township trustees for that purpose, and shall file and preserve all papers pertaining to the said board of commissioners, or either ofthem, and pertaining to their duties, all of which shall be a part of the public records of said township, and he shall receive such reasonable compensation for such services as the township trustees may allow.

SEC. 4. It shall be the duty of said board of fruit commissioners, upon or without complaint or upon actual observation by any one of them, to proceed in a body (which shall be construed to mean any two of them) without delay and examine the trees or fruit supposed to be infected, and if any of said diseases is found to exist by said board of fruit commissioners, they shall place upon the diseased trees a distinguishing mark, and shall place upon the fruit so diseased, or which came from any tree so diseased, a placard, and indorse thereon the diseased condition of such fruit, and they shall forthwith cause notice in writing to be served upon the owner of the same, if he be a resident within the county, and if the owner be not a resident of such county, then such written notice may be served upon the person having the same in charge for the owner or agent, employe or lessee or otherwise; such notice may be served personally or by copy left at the usual place of residence of any such person, and if no such person resides within such county upon whom service can be made, then such notice may be served by mail by being deposited in a post-office, postage prepaid, and addressed to the post-office address of such person wherever he may reside. Such notice shall contain a simple statement of the facts as found to exist, with an order of said board of fruit commissioners to remove and destroy the trees so marked and designated, and the parts so infected with the black-knot, and the fruit so marked by placard, within ten days from the date of services of said notice (Sundays excepted); and if any person whose duty it is hereby made to destroy the same, fails, neglects or refuses to destroy the same as mentioned in such order of said commissioners for a period of ten days after service thereof, then the said commissioners be and they are hereby authorized and required to enter upon the premises of any person and destroy all of such fruit trees or fruit so mentioned in their said order and so found to be so diseased, which they have so marked or placarded, and said commissioners are hereby authorized to employ help and secure all the necessary means to so destroy the same, all of which shall be allowed by the township trustees and paid out of the township treasury; provided, however, that any person owning any of said fruit trees or fruit, or any person having the charge, control or supervision thereof, as agent, employe, lessee or otherwise, or any person who may have an interest, in any manner in any of said trees or fruit, or any part thereof, shall have a right to have the question whether any of said trees or fruit is so diseased or whether any of said fruit came from any trees so diseased, and the question whether any of said trees or fruit or any part of the same is a nuisance, or any of said questions, to be determined by a jury of twelve freeholders of said township; provided, that such person, within the period of ten days from receiving such order from said commissioners, shall make his application to a justice of the peace of said township, or to a justice of the peace ot an adjoining township, in case there is no justice able or competent to attend to such proceeding, and shall notify the said commissioners thereof as hereinafter mentioned; but if any such person shall fail, neglect or refuse for such period of ten days after receiving such notice and order from said commissioner[s], to make such application to any such justice of the peace and notify the said commissioners thereof of his intention to have such questions so tried by a jury, then he shall have waived any and all right to have such jury to determine such question or any of such questions, and such order of said commissioners shall be forthwith executed by said commissioners; but in case such application shall be so made for a jury, the said commissioners shall suspend temporarily their said order, which shall be executed thereafter, modified or suspended, abandoned or executed in whole or in part, by the said commissioners, as they shall be directed by the verdict of said jury.

SEC. 5. Any person receiving any such order from said commissioners intending to contest the question of said trees or fruit being so affected, the question of whether any of said fruit came from any trees so affected, or the question of whether the same or any part of the same is a nuisance, or intending in any manner to resist the said order of said commissioners, shall, within ten days from the time of receiving the said order, file his application in writing with any such justice of the peace for such jury and serve notice thereof upon said commissioners, in writing, as mentioned in section 4. and the said justice shall enter said cause upon his docket and the board of commissioners who issued such order shall be the plaintiff and a party of said action, and the person complaining shall be the defendant thereto. Upon docketing such cause and immediately upon filing of such application with such justice, the said justice shall issue a venire for a jury of sixteen freeholders of the township where said justice resides, returnable on the fifth day thereafter, which shall be served by any constable of said township, and said justice shall also at the same time issue a notice to said board of commissioners to be served by any such constable, and said notice and venire shall state the nature of said cause and mention the time and place where the same will come on for hearing. At the time and place so fixed for such hearing the board of commissioners shall appear and prosecute their said action, and in all such proceedings shall be known as a party thereto, and the said jury shall be duly impaneled, sworn and qualified and made up in the matter of challenges and qualification, and all other particulars as are provided by law, in civil cases in the courts of common pleas. The only pleading required in such cause is the order of said commissioners and the issue joined shall be the issue made by such order, and the trial shall be conducted in all respects, as far as are applicable, as trials in civil cases are conducted in common pleas courts, except that the verdict of said jury may be the affirmance of said order of said commisioners, a reversal thereof, a modification, or suspension of the same or of any part thereof, and after the verdict of such jury, the said commissioners shall execute the said order or suspend the same or execute the same as directed by said verdict, and from such verdict there shall be no appeal.

SEC. 6. The justice of the peace, constable, witnesses and jury shall receive such fees as are now provided by law for such officers before justices of the peace in civil cases, to be taxed as a part of the costs in such proceedings, and the same, together with the fees and expenses of said board of commissioners in attending such proceedings, and all other expenses and fees of said board of commissioners, shall be allowed by the trustees of said township and paid out of the township funds, and in all cases where the order of the said board of commissioners shall be sustained by said jury, and in cases where said commissioners shall execute their own order upon default of the person whose duty it shall be to execute the same, the costs shall be paid by the party whose duty it shall be to execute such order, and in case of his failure to pay the same after demand made by the trustees of such township, the said trustees shall certify the same, together with a penalty of fifteen per cent., to the auditor of the county, to be placed upon the tax duplicate, and the same shall become a lien upon the premises of such person from the time of filing the same with the auditor, and collected by the county treasurer as other taxes.

SEC. 7. An act entitled "An act to amend section 1 of an act entitled 'An act to eradicate the disease known as 'black-knot' on plum and cherry trees,'" passed April 13, 1893 (vol. 90, p. 176), is hereby repealed, and this act shall take effect and be in force from and after its passage.

Passed April 4, 1894.

Correspondence is solicited concerning the Russian thistle and other weeds; also concerning fungous diseases of plants.

Address OHIO EXPERIMENT STATION,
Wooster, Ohio.

BULLETIN

OF THE

Ohio Agricultural Experiment Station.

NUMBER 56. DECEMBER, 1894.

THE SAN JOSÉ SCALE. (*Aspidiotus Perniciosus*, COMSTOCK.)

BY F. M. WEBSTER.

This depredator is an entirely new one to attack the orchards of Ohio, and no originality is claimed for the information here given, as, at time of writing, only a month has elapsed since I first learned of its existence in the State. As this time is included within the dormant period, it will be at once observed that no opportunity has been offered me to make personal observations, so that the matter here given, though not my own is the best information that we have, up to date, and is given to the people of Ohio in order that they may secure all benefits possible therefrom.

The pest first made its appearance, so far as I have been able to learn, in Clermont county, on apple trees purchased four years ago from the J. T. Lovett Co., of Little Silver, N. J., where it had probably occurred since 1886 or 1887, though unknown to the public, and, doubtless, also to the proprietors. As stated further on in this bulletin, the introduction of the pest from California was clearly unintentional, and for this the two firms of New Jersey nurserymen should not be held as responsible as if the introduction had been done knowingly. And, so far as a disposition has been shown to stamp out the pest, and disinfect their trees, thereby to the best of their ability protecting their customers, they should continue to receive lenient treatment. They should be considered as unfortunate, but not intentionally unjust, and should continue in the confidence of the people of both their own and other States, in proportion to their efforts to eradicate the pest, and deliver to their customers uninfected stock—where there was evidently an honest intention to prevent further diffusion of the pest. It must not be supposed that all trees coming from an infested nursery are necessarily affected, and while the best and most effective treatment of infested stock might leave an occasional living scale on a limited number of trees, yet such treatment will reduce the probability of diffusion to the minimum. So far as known, reproduction and consequent diffusion are impossible unless both sexes, or, females already fertilized, are present; therefore to establish a colony in any orchard it would be necessary for several scales of both sexes to be introduced to such orchard, which will be less likely to occur among trees previously disinfected than otherwise. If, as is possible, the males are easier killed than the females by fumigation or other remedial measures, the prospect of infection by thoroughly treated trees is even more reduced. It would seem as though if a nurseryman were to take these precautions, and when he sends out his trees, inform his customers of their exact condition, asking that close watch be kept, offering to replace all infested trees, provided proof of infection and prompt destruction of such trees were furnished by the purchaser, within two years of date of sale, it would solve the problem of stamping out the pest in the States east of the Rocky Mountains. If, however, the course that some eastern nurserymen appear to be following is pursued, such must not complain if their stock is prohibited by legislative action from being shipped into many of the States. Certainly, no reliable nurseryman can afford to act otherwise than uprightly in this matter, and such owe it not only to their customers but to each other to do so.

In regard to the outbreak in Ohio, I received notice through Hon. L. N. Bonham, at that time Secretary of the State Board of Agriculture, who forwarded a letter accompanied by specimens from Clermont county. The notice was received on December 19, and the next morning I was on the ground inspecting the orchard from which the infested bark came. The orchard comprised about 600 trees, probably one-third of which were more or less infested, twenty-five at least so badly as to preclude all possibility of saving them, and at least double that number that could only be utilized by cutting off the trunks a short distance above the ground and grafting them, first disinfecting the stumps. The pest had been noticed the previous year, but its dangerous nature not being understood, it was allowed to go on until it became apparent to the owner that it was no common enemy with which he had to cope. A smaller orchard set at the same time and with trees from the same nursery, was found infested to a much less extent, though in this case the scales were badly scattered through the orchard. In the latter case, it would appear that only one tree had been originally infested, from which the others, had been colonized. The lateness of the season prevented me from making any further investigation, and the only observation worthy of mention was the finding of a single individual of the twice stabbed lady-beetle attempting to climb a tree, probably in order to feed upon the scales, as they are known to destroy them in great numbers. This lady-beetle is small, nearly round or turtle shaped, shining black, with a small, round, red spot in the middle of each side of the back. Among entomologists it is known as *Chilocorus bivulnerus*, and it is this insect for which a California fruit grower, a few years ago, offered to give an equal weight of gold for any amount that would be sent him, provided they reached him alive. I need hardly add that the owners of these two orchards will take this scale in hand and stamp out the pest before it gets a stronger foothold or becomes more widely spread.

Considering the very serious nature of the pest, it was thought best to give a short notice to the Columbus, Ohio, city papers, in order to put people on their guard, as well as to encourage searches among other young orchards. This resulted in bringing out the following letter, which was forwarded to Wooster from Columbus:

"LITTLE SILVER, N. J., *December* 28, 1894.

Director Ohio Exp. Sta., Columbus, Ohio:

DEAR SIR: One of our customers has sent us a clipping from a Columbus paper, in which is stated that trees owned by one Mr. Nicolis have been found infested with the San José scale. You will please give us all the information you can in regard to this matter. We would like very much indeed to have some branches from the trees referred to for examination ourselves. We have made a critical examination of our trees here in the nursery and also fruiting trees, using the microscope, and can find no trace whatever upon any of them of the San José or other scale. Having read reports upon the San José scale, we are confident that we could detect this insect if it existed upon our trees.

Yours truly,

THE LOVETT COMPANY.

[Signed] H."

Regarding the above letter, I very much regret to say that this Station has the very best of evidence to show that late in September, several months before the date given, a thoroughly competent entomologist went through this nursery, accompanied by both the president and secretary of the company, calling their attention, at the time, directly to the fact that every tree in their nursery, apple and pear, was infested by this scale. And also that this entomologist pointed out to them, then and there, several old trees that were simply coated with the scale, and which they promised to take out at once. Further comment seems unnecessary.

In regard to the original home of the San José scale, nothing is known with certainty. For a time it was supposed that it had been introduced into California from Chili, South America, but later investigations have cast considerable doubt upon this, and it now seems probable that we may find its original home to be on some of the islands of the Pacific ocean.

The pest was first noticed at San José, California, in 1873, though it doubtless occurred there several years previous. It was described in 1880 by Professor Comstock, who found it swarming in myriads in certain orchards. Since the latter date, it has spread through California and Oregon into Washington, and has caused immense losses of fruit, and thousands of trees have been destroyed by its ravages. It seems to have proven to be what the describer termed "the most destructive of the scale-making Coccids."

As before stated, New Jersey was the first State to develop this pest, east of the Rocky Mountains, so far as now known at least, and Professor John B. Smith, entomologist of the experiment station of that State, has recently published a bulletin relating to its occurrence in his State, which publication also included another sent out by the United States Department of Agriculture. In the following pages I have appropriated Professor Smith's bulletin almost entire, because it is the latest and best information received at date of issuance of this bulletion.

It is to be hoped that any occurrences of the pest in Ohio will be promptly reported to the Station, which will do all in its power to aid in stamping it out wherever it appears, though in doing this we shall expect the owners to come to the front and help themselves.

I understand that the entomologist of the U. S. Dept. of Agriculture is at present experimenting with the hope of securing a more effective wash for winter application, and presume that the results will be communicated to the people as soon as secured.

"In the summer of 1893, Dr. C. V. Riley, then U. S. Entomologist, announced to the Association of Economic Entomologists, meeting at Madison, Wisconsin, that the insect had been found infesting a small orchard at Charlottesville, Virginia. At that time the source from which the infection came was not known, and an accidental introduction on infested fruit was deemed probable. Radical measures were to be adopted to stamp out what was then supposed to be a solitary plague-spot.

"In April, 1894, a circular was issued from the Division of Entomology, U. S. Department of Agriculture, calling the attention of fruit-growers to this scale, stating its history and spread, enumerating the points in the East at which it was known to occur, and closing one paragraph with the words: 'The owner stated that the scales were first noticed three years ago, and expressed himself as of the opinion that the insect was brought into this orchard on nursery stock purchased from a New Jersey dealer.'

"This attracted my attention at once, and I decided to find the offending nursery or nurseries, to check, if possible, further distribution of the pest. Letters were sent to the leading establishments in our State, and I made excursions in rapid succession to those points where horticulture is a leading industry, examining the stock in the hands of dealers, and also many orchards recently set out. I soon located two nurseries, both large and well known. which were infested by the scale, and these, so far as I have been able to ascertain, are the only distributing centers in our State. It is not deemed necessary to name at this time the establishments which have unintentionally introduced the scale into New Jersey and into a number of surrounding States. The gentlemen concerned acted in ignorance and not in bad faith; they are taking active steps to stamp out the insect on their bearing trees, and have adopted measures which will, if faithfully carried out, prevent the shipment of other infested stock. It is also considered advisable to induce farmers to examine all fruit stock carefully before setting it out, and to that end they should be suspicious of *all* nurseries.

"This is perhaps as good a place as any to say that there are several nurseries on Long Island in which the scale is present; that one at least, in another part of New York State, is suspected, and that in Missouri we know of another which has distributed scaly stock. All material, therefore, whether received from our own or foreign nurseries should be critically looked over before being set out.

INTRODUCTION OF THE SCALE.

"The history of the introduction of the scale is practically the same at both the infested nurseries in our State. In either 1886 or 1887 each imported from California a lot of Kelsey plum trees, the fruit of which was said to be "curculio-proof," and otherwise desirable, and with them other Japanese varieties were also received. In both cases the trees looked bad, were weak, made little growth, and after remaining in the nursery for two years were taken out and destroyed. It was afterward remembered that they seemed scaly; but no especial attention was paid to this at the time, and the nature of the scale was not suspected. It is almost certain that these trees carried this scale in large numbers, and from them the insects spread to the nearest bearing fruit trees, on which they multiplied exceedingly. In one case a row of Bartlett pear trees adjoined the block in which the Kelsey plums were grown, and these I found to be covered from base of trunk to the tip of the twigs; scarcely a bit of bark being visible. The trees were nearly dead, and were at my suggestion taken out at once and burnt. From this row of trees the scales annually spread to the nursery stock round about, so that in an entire block, containing thousands of young fruit trees, scarcely one could be found without a few scales fixed on it. At all events, in both instances, the scale spread rapidly, and about 1889 or 1890 the first scaly stock was distributed. Since that time every year has continued the distribution of the insects, though it is probable that in the majority of instances they failed to establish themselves in their new homes. There is reason to believe that some Idaho pear stock, received from Western nurseries and shipped without further growth to purchasers, was also infested when set out.

SPREAD OF THE SCALE IN NEW JERSEY.

"It was considered important to ascertain just how far the scale had been distributed in our State, and to what extent the insect had spread from the points at which it was introduced. The nurserymen could and did give me willing and efficient assistance here, and furnished lists of names of persons to whom suspicious stock had been sent for five years past. These lists aggregated nearly 1,000 names, and to each individual a letter was written, inclosing a copy of the circular above referred to as published by the U. S. Department of Agriculture. A supply of these circulars was kindly furnished the Station at different times by the Department, through Dr. C. V. Riley and Mr. L. O. Howard, each at the time holding the position of U. S. Entomologist, and these gentlemen have in all ways facilitated my work by suggestions, information and assistance. Replies to my letter were received in considerable number, and I soon located a number of infested orchards and centers of infection. I realized that I could not depend upon correspondence alone in this matter and spent more than twenty days in active field work, examining thousands of trees and visiting a very large number of orchards. My plan was to visit one of the horticulturists on my list, and have him drive me about in his neighborhood; especially to those places where young orchards had been recently set out. Thus, I found a large number of places where the scale was present, and owe thanks to the gentlemen who so willingly gave their time and local knowledge to aid my investigations.

"The result has been, on the whole, encouraging. In one case only had the scale spread beyond the trees that were infested when received from the nurseries; and while many of these were so badly infested that I advised taking them out immediately, I believe that in most instances they can be easily cleaned. I found, curiously enough, that all the infested orchards are south of the red shale. This formation crosses the State obliquely from Island View, opposite Staten Island, on the Atlantic Coast, to Trenton, on the Delaware, and extends northward; clay, marl, loam and sand succeeding it to the south. I do not mean to assert that the scale does not exist on the red shale or northward; but simply that I have not found it there, and have not had any information which leads me to suspect its presence. South of the border indicated I have located the insects in every county. It is certain that climate has nothing to do with the absence of the pest in the northern half of our State, because it is known to exist on Long Island and in an orchard in Columbia county, N. Y., and it may be accident, merely, that is responsible for the apparent exemption from attack of the region mentioned. It will not do for farmers to assume that the scale cannot maintain itself in localities thus far uninfested; but, on the contrary, they should be especially cautious not to introduce it where it does not already exist. Nothing will be gained by enumerating the orchards in which this insect occurs, or even the townships in which they are located; there are nearly one hundred of them known to me, and probably there are more in places not visited, and from which I received no replies to my letter. It is probable, also, that the insect exists on fruit trees in some of the gardens in the many towns and villages along the Delaware, and within a short distance south and west from Camden on all the railroads. Its absence should be nowhere assumed.

CALIFORNIA FRUIT INFESTED.

"While, so far as we know at present, all the existing scales in New Jersey are traceable to nursery stock, yet there exists a continuous danger from California fruit, and especially pears. I found in the markets of Philadelphia, Newark, New York and Brooklyn any number of pears with this scale conspicuously present, and noticed it on some of the fruit sold on the trains out of Philadelphia and New York. At the meeting of the Association of Economic Entomologists, at Brooklyn, N. Y., during August, 1894, this insect was discussed, and I purchased at the first handy fruit stand half a dozen California pears and exhibited them. Every fruit was infested more or less, male and female scales being equally abundant, and on one fruit the active yellow larvæ were found in some numbers, crawling about and seeking a place to fix. Should a pear of this kind, or the peelings from it, find lodgment near or on any plant suitable for its existence, there would be nothing to prevent the establishment of a colony.

LIFE HISTORY.

"As the study of this insect is a matter of national importance, it has been taken in hand by the Division of Entomology of the U. S. Department of Agriculture. Indeed, the insect had been studied, and its life history ascertained in California years ago, so we are quite familiar with its general habits and development. I deemed it unnecessary to duplicate work, and have made no attempt at an original study. I have confined myself to observing the development and habits of the insect in our State, and to ascertaining those points that are practically important in its treatment. The life history that follows is therefore taken in its essential features from Circular No. 3, Second Series, of the U. S. Department of Agriculture, Division of Entomology, supplemented by my New Jersey observations. The illustrations are also from the above-mentioned circular, electrotypes being procured by the courtesy of the officers of the Department.

"The San José scale (Figs. 1 and 2, Plate I) belongs to the group of armored scale insects to which the common oyster-shell bark-louse of the apple belongs. It differs from that species in that the scale is perfectly round, or at most very slightly elongated and irregular. In these particulars it resembles the "scurfy scale," *Chionaspis furfurus,* or "Harris louse," as it seems to be quite universally called in this State; but it is decidedly smaller and more convex than the latter species. Its round shape and small size distinguish it at a glance from the other species infesting deciduous fruit trees in our State. It is quite flat, a little raised in the center, pressed close to the tree around the edges, resembles the bark of the twigs in color, and when full grown is decidedly less than one-eighth of an inch in diameter. Perhaps the majority of the scales do not equal one-sixteenth of an inch where they are closely crowded together; but where a few only are found on the succulent shoots, or on fruit, they become larger, and the females may in extreme cases reach nearly one-eighth of an inch. The males (Fig. 5 rarely) exceed one-sixteenth inch in diameter. At or near the middle of each scale is a small, round, slightly elongated black point; or this point may sometimes appear yellowish.

"When occurring upon the bark of twigs or leaves in large numbers the scales lie close to each other, frequently overlapping, and they are at such times difficult to distinguish without a magnifying glass. (Fig. 2, Plate.) The general appearance which they present is a grayish, very slightly roughened, scurfy deposit. This is much more prominent on trees like the peach, or those varieties of apple and pear that have a reddish color, and when these are thickly infested they seem to be coated with dust or ashes. When the scales are crushed by scraping, a yellowish, oily liquid will appear, coming from the soft yellow insects beneath the scales, and this will at once indicate to one who is not familiar with their appearance the existence of healthy living insects beneath the scaly covering.

"They are easily scraped off with the finger nail, and the bark beneath them will be seen to be darker in color. The natural color of the bark is also somewhat changed, as will be seen by comparing the places from which the scales have been removed with the spots upon which the scales do not occur, while the circumference beyond the scales frequently become changed in color to a somewhat purplish or crimson shade. Where the scales do not occur so thickly they are more perceptible, and upon young, reddish twigs the contrast is quite noticeable as the scales there appear light gray. Younger and smaller scales are darker in color than the older and larger ones, and sometimes appear quite black; while on the other hand, those that are just set may be white or yellowish.

"During the winter the insect is to be found in the half or nearly full-grown condition, and as soon as the trees resume activity in spring the insects resume their feeding. In New Jersey they reach their full growth during the latter part of May, and the young begin to hatch and to crawl from under the female scales during the first week in June, and from this time through the summer there is a constant succession of generations. The first living larvæ that I received reached me June 11, having been gathered June 10, and at that time I found on the twigs a number of young scales (Fig. 3, Plate) that had just set, indicating that active larvæ had been about at least three or four days previously. Up to June 15, every infested tree examined showed active young larvæ, and after that time there seemed to be a period of about a week or ten days during which no larvæ were noticed. Early in July, however, young larvæ were again active and crawling about everywhere, and this condition of affairs continued throughout the balance of the summer, extending through October, and even into the first part of November; until, in other words, the trees had become quite dormant. The young louse is an active, crawling creature, very minute and yellowish in color. The young (Fig. 3, Plate) spread out upon the new growth of the tree, settle down, and each begins to secrete a scale. The male (Fig. 5) is an active two-winged insect, while the full-grown female (Fig. 4, Plate) loses her legs and antennæ, and bears a very slight resemblance to a living creature.

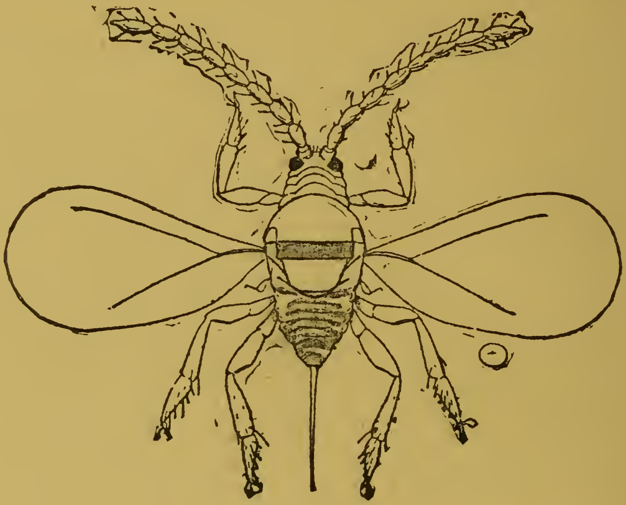

Fig. 5.
SAN JOSÉ SCALE — Male adult—greatly enlarged.

"The insect affects not only the young twigs and limbs, but covers as well the trunk to the surface of the ground, and exists upon the leaves and upon the fruit. When it is abundant the fruit is destroyed, or at least rendered unfit for market. One of the most characteristic points in the appearance of the insect upon fruit is the purple discoloration around the edge of each scale. So far as we know, this result is confined to this species alone. Upon the leaves the insects have a tendency to collect along the midrib on the upper side of the leaf in one or more quite regular rows, and also to some extent along the side ribs. The infested leaves turn brown, but do not have a tendency to fall as a result of the damage.

"There are two points of interest and importance to be noted in this life history. The first is, that the insect passes the winter beneath the scales in a partly grown condition. Usually they are about half grown; but some will be younger and some will be older. They seem to continue reproduction until the tree is entirely dormant, and no further food is obtainable. On the other hand, they do not seem to renew growth very early in spring, but are slow to begin reproduction; no larvæ having been noted until June, as has been already stated. The second point is, that once they begin there is practically no period during the summer at which the young, active crawling lice are not to be found upon the tree. The length of time during which a given female will continue to reproduce has not been ascertained; but it seems likely from what has been observed that breeding continues for quite a long time, and that the female scales that have lived during the winter may continue to live on and reproduce during the greatest portion of the summer, when their daughters and grand-daughters are already full grown, with nearly full-grown progeny. There may be, therefore, upon a plant at one time, young born of as many as three or even four distinct generations. As nearly as I have been able to ascertain from my observations during the present season, a little less than a month is required to bring an insect to maturity. That is, a larva hatched today will be ready a month hence to bring forth living young in turn, and this will allow at least four if not five distinct broods during the summer and fall.

HOW THE INSECT SPREADS.

"It has been stated that the male of this species is a winged insect. It is very minute, scarcely noticeable without a lens, very light and frail, at the mercy of the least puff of wind, and incapable of any great journey. The female has no perceptible legs, and is utterly incapable of motion. She resembles a yellowish or orange, flattened seed, in bulk many times that of the male; but firmly fixed to one point by the scaly covering which is at once her protection and her grave. The young are active for a very brief time, two or three days at most, and they crawl with considerable rapidity and great persistence, so that they might possibly descend from one tree and crawl for a number of yards to another; but the spread in this manner is insignificant. Where trees are close together they may pass from the branches of one to the branches of another; but I have found that they rarely crawl long in any one direction; they rather move around, rapidly enough, yet irregularly and at random. Usually they do not go further than is necessary to find a good place to fix, and at once begin to form a scale. This process is rather interesting and can be watched. As soon as the young louse has inserted its beak into the plant, and has begun to feed, a change comes over it, and within a few hours it is entirely covered by a fine, white, waxy film. This turns first yellow and then gray or even black, and the creature is a fixture, absolutely incapable thereafter of shifting its location under any possible circumstances. Strong winds may carry the young bodily from one tree to another; but the principal method of spread is by means of other insects which are winged and by birds. The active young lice will soon crawl upon any small winged insect, particularly if the latter is of dark color, and they may be carried by it to considerable distances. They also crawl upon the feet of birds which visit the trees, and may thus be carried for miles. They are often found upon ants, and ants, as everyone knows, are great travelers. This difficulty in moving from one place to another, and the dependence upon external agency for their distribution, will account for the fact that trees here and there in an orchard newly set out, may be very badly infested, while not a trace will be seen on the trees on either side. Few birds or insects visit a young orchard that is at all well kept, and the distance between the trees, especially if the land is cultivated, is altogether too great to be covered by the young lice, even did they know enough to make a bee-line for the nearest point. The result is that everything fixes upon the tree on which it was hatched, killing it more rapidly than would otherwise be the case; but at all events confining and preventing spread to points not theretofore infested. This also explains why nursery stock is so evenly troubled; here the trees are grown just as closely together as is possible, in rows, and there is no hindrance to crawling from one to the other.

"As the insects must feed for a time in spring before attaining their full growth, it follows that only such as are fixed to the tree itself have any chance of reproducing their kind. Those that fix to the leaves fall with them, and as these dry or decay the insect dies for want of food before attaining maturity. We have, thus, to consider only the wood, free of all leaves, when attempting the destruction of the insect.

VARIETIES OF FRUIT INFESTED.

"All our deciduous fruit trees are attacked by this insect; though not to the same extent. In addition, currant, gooseberry and rose-bushes are infested, and it is probable that the entire natural order *Rosaceæ* will support the species. In addition, a single specimen of a European variety of elm was found densely covered by it, and I found a few specimens apparently of this species on an English walnut, growing next an infested pear tree. Comparatively few scaly peach trees were found in my observations. This is due to the fact that the infested nurseries do not grow their own stock of this fruit, but have it grown elsewhere. It is shipped to them in bulk, heeled in, and reshipped as ordered. Anything left over is destroyed. Apples, pears, plums and cherries are the usual victims, and pear trees more than any others. Quince is more rarely troubled. Among the plums the Japanese varieties are favorites, while those of American and European origin suffer much less. The apples seem to be equally affected, and I noticed no markedly exempt varieties. Pears differ greatly in susceptibility. European stocks and varieties are nearly equally subject; Idahos, in my experience suffer most, closely followed by the Lawson, Garber, Madam von Siebold, Sin-Sin, Lawrence and Bartlett. The varieties of pears are legion, and all of them support the scale. The Japan Golden Russet is a vigorous grower, and is not a favorite with the insect. Still less infested is the Leconte, while the Keiffer is almost exempt. A striking example of this difference I found in a tree upon which both Lawson and Keiffer were grafted; the Lawson branches, leaves and fruit were completely covered, while the Keiffer portion was entirely free from scales. In several instances where Keiffers were set in trial-rows with other varieties, the branches intermingling, the Keiffers were entirely clear, while all the others were more or less infested. The Leconte was nearly as fortunate, and where there is opportunity for choice these varieties will be exempt. I was inclined to believe that the Keiffer was scale-proof until October, when I received specimens of infested twigs of this variety, and learned of an orchard of these trees in which the insects were abundantly present. I have learned since that time of several instances where this variety has been more or less troubled, and no further doubt exists, therefore, that under proper conditions—unfortunately we do not yet know what these conditions are—the insects will exist and multiply on it as readily as on any other. Yet withal, the Keiffer is least likely to be attacked in my experience where other varieties are at hand. But it is not exempt, and no variety is entirely immune.

NATURAL ENEMIES.

"I have been asked on several occasions whether this insect had no parasites. It has. I have bred specimens of *Aphelinus fucipennis*, Howard, a very minute, yellowish, parasitic wasp, from the scales in moderate numbers, and this same species has been bred from it in California. I am informed by Mr. Howard, U. S. Entomologist, that up to September no parasites had been bred in the East by any investigator other than myself, and also that this little *Aphelinus* occurs all over the country, and is a foe to scale insects generally. Not one per cent. of the scales collected by me and carried through in the laboratory were parasitized, and in the field it was difficult to find a destroyed specimen. As a slight check to increase, this little species has a value; but no actual reduction, or even a restriction to present numbers, is to be hoped for from its efforts. It is only fair to add, however, that in one case in California the insect 'had been found doing such effective work in subduing the species in an orchard in the neighborhood of Los Angeles, that a complete restoration of the orchard was confidently expected.'

"Two species of lady-birds were also observed in some numbers feeding on the scale. The most prominent was *Chilocorus bivulnerus*, the 'twice-stabbed lady-bird,' which is black, almost hemispherical above, one eighth of an inch in length, and has a blood-red spot in the middle of each wing-cover. The other species is *Pentilia misella*, to which no common name has been applied, and which is a minute black creature, scarcely as large as the scale itself. These beetles and their larvæ undoubtedly devour many of the scales and their larvæ; but they do not occur in numbers great enough to check the increase and further spread of the pernicious scale.

"No trust can be safely placed in these natural enemies. A little active winter work *now*, will benefit the farmer more than all the 'natural enemies' can possibly advantage him in ten years to come.

REMEDIES.

"This scale can be so much more satisfactorily treated in winter that I strongly urge an attack upon it during the present season. No fruit-grower, on ever so small a scale, can afford to allow this insect to remain on his trees, and all farmers should carefully examine every tree received and set out within the six years last past, to make sure that the pest does not exist upon any of them.

"Our large orchardists are, as a rule, careful of their trees, and many are in the habit of winter-treating them. In two or possibly three instances, I feel convinced that the scale has been killed off where it was present without the knowledge of the owner. In one case the trees were washed with a saturated solution of commercial potash; in another the trees were kept constantly whitewashed; in the third, and doubtful case, whale-oil soap was used, and here I am not so certain that the scales had been really present. In another instance I found a number of apple trees with a few scales near the tip of the twigs, and a very few on the fruit. In this case the arsenites and Bordeaux mixture are used each year, and whenever the trees are sprayed the trunks and larger branches receive a special coating. No scales were found there, and though the trees had been set out five or six years, and must have been infested when received, they were thrifty and vigorous. The scale had barely maintained itself, and there were probably fewer specimens than when the trees left the nursery.

"If such good results follow from what is considered by some of our horticulturists merely proper care of an orchard, we may reasonably hope that special treatment directed to the extermination of this particular scale may be even more successful.

"In selecting materials to use for the destruction of scales, we have to consider, first, the character of the creatures to be reached, and second, the way in which we expect to reach them. The insect itself lies close to the bark, completely covered and protected by the scaly secretion which is closely applied to the surface by its entire circumference. We must, before we can get at the living creature, either corrode or dissolve the scale; we must employ an agent subtile enough to penetrate any minute opening, able also to kill the specimens when it reaches them; or we must coat the scale with a wash which will fix it permanently to the tree and which cannot be penetrated by the males when they seek to emerge, or by the larvæ should the female scale be fertilized.

"As a solvent or corrodent, lime is of some use; but only when freshly slaked and to a small extent. It is not sufficiently certain for use in this case. Caustic soda and crude potash are very much better and more reliable. Potash is used by a number of our growers as a winter wash, and it has proved effective in destroying the scurfy scale, and the oyster-shell bark-louse. In California, so it is stated in Dr. Riley's report as U. S. Entomologist, for 1893, 'a seriously infested orchard was treated with absolutely complete success, by means of a wash composed of one-half pound of commercial potash, one-half pound of caustic soda, and five quarts of water. This was applied when the trees were in a dormant condition.'

"Both potash and soda corrode the scales, and when they reach the insect, burn through it as well. Potash is used in my laboratory practice to destroy rapidly all muscular and other tissues of the insects I wish to prepare for study, leaving only the chitinous framework, and even this is dissolved in time. This substance is, therefore, theoretically and practically a good one for the destruction of scale insects. Potash alone will act as well as in combination with soda, and may be purchased in one hundred-pound lots at seven cents per pound. If this is used, it should be as a saturated solution; *i. e.*, use only water enough to fully dissolve all the potash, and this will be facilitated by heating the water. Apply thoroughly to the entire tree when it is dormant.

"As a penetrating material nothing is better than kerosene. It will find its way through the smallest opening, and where used pure, will kill every insect with which it comes into contact. To dormant trees it may be applied pure, and where thoroughly used will prove effective. It is, however, even more effective when emulsified with soapsuds and somewhat diluted. The formula is as follows:

Hard soap, shaved fine	½ pound.
Soft water	1 gallon.
Kerosene	2 gallons.

"Dissolve the soap in boiling water, add to the kerosene, and churn with a force-pump until a smooth, white, butter-like mass is formed which adheres to glass without oiliness. The hotter the liquids are when they are joined, the sooner the emulsion will be formed. If the kerosene is warm, the soapsuds boiling hot, the pump or syringe not cold, from three to five minutes will perfect the emulsion. Stirring with a stick will not answer, nor will any agitation less violent than that obtainable with a syringe or pump produce a satisfactory result.

"For application against this scale dilute with five parts of water and apply liberally. The kerosene in this mixture does not evaporate so readily as when applied pure, and more opportunity is given to penetrate the scale. The caustic of the soap is also of use in loosening the scale and facilitating the entrance of the oil. An excess of soap in the emulsion is therefore no fault, and the emulsion is apt to be more readily made. The water should be soft for best results in making the emulsion; but hard water can be used to dilute.

"The resin washes, which are general favorites in California, act by forming an impervious coat over the insects, and also through the caustic they contain.

WINTER WASH.

Resin	30 pounds.
Caustic soda, 70% strength	9 pounds.
Fish oil	4½ pints.
Water sufficient to make	100 gallons.

SUMMER WASH.

Resin	20 pounds.
Caustic soda, 70% strength	5 pounds.
Fish oil	3 pints.
Water to make	100 gallons.

"To make: Dissolve the ingredients by boiling in water sufficient to cover, and when this has been done add 40 gallons hot water. When used add enough cold water to make 100 gallons. Keep the ingredients boiling continually during the dissolving process.

"They would not be as satisfactory with us, because our frequent rains would wash off the mixtures before they had an opportunity to become fully effective. They are also better for use in summer, when the young are active, than in winter, when, in my opinion, the most radical measures are possible.

"A great many experiments have been made by the United States Department of Agriculture with all the substances recommended for use in California, and which have proved more or less effective in the East. Mr. L. O. Howard, United States Entomologist, wrote me November 19: 'I have pretty well determined, however, that we will be obliged to abandon the lines generally worked on in California—that is, lime, salt and sulphur; lime sulphur and blue vitriol; winter resin wash, and strong kerosene emulsion. None of these killed off all of the scales, although all reduced their numbers to a greater or less extent. There is unquestionably, a more perfect dormancy on the part of the scales here than there is in California, which probably alone accounts for the comparatively poor success of these washes. The only thing which I have found, so far, which I can say is almost absolutely complete in its work, is a solution of two pounds of whale-oil soap to one gallon of water. A tree which Mr. Coquillett sprayed with this mixture the third week in October was examined by me yesterday, and although I spent nearly an hour going over the tree, I failed to find a single living scale. Even those which had worked their way down between the scales of the buds were killed.' Whale-oil soap is rather expensive, and especially if it is to be used at the strength recommended—that is, two pounds to one gallon of water. A fish-oil soap can be made, however, without difficulty by farmers themselves according to the following formula:

Crystal potash lye	1 pound.
Fish oil	3 pints.
Soft water	2 gallons.

"Dissolve the lye in the water, and when brought to a boil add the oil. It should boil about two hours, and when done can be filled up to make up the loss by evaporation.

"This will make a batch of about twenty-five pounds, or enough for thirteen gallons of water. It should be applied with very great thoroughness, so as to wet to dripping every portion of the tree. The cost will be about one cent per pound.

"It remains, finally, to mention the gas treatment. This has been much used in California against scale insects infesting Citrus trees, and is extremely effective. It is also quite expensive; not so much in the materials used as in the outfit required. Essentially it means inclosing the tree to be treated by an oiled canvas tent, and producing in this confined space hydrocyanic acid gas, by means of the action of diluted sulphuric acid on fused cyanide of potassium. The proportions are, one ounce by weight of not above sixty per cent. cyanide of potassium, one fluid ounce commercial sulphuric acid, and three ounces water. This is sufficient for an inclosed space of one hundred and fifty cubic feet. After a tree is inclosed, the water is first poured into any glazed earthenware vessel; the acid follows and the receptacle is placed under the tent. The cyanide is then added, and the gas at once begins to arise. It is lighter than air, and displaces the latter in a very short time. It is also excessively poisonous, and deadly to all animals, including man, and care should be taken not to breathe it. The trees should remain exposed to the action of the gas about one hour, and this will generally kill all the scale insects infesting it, and will rid it also of all other sorts of insect life that is not in the egg or pupa stage.

"It has been found that warmth and daylight affect the action of the gas, making it more dangerous to plants and less deadly to insects. Fumigation, therefore, is best made at night, or late in the afternoon of a cool day, when its action on insects is at its maximum and its effect on plants at a minimum.

"This treatment is not recommended in New Jersey, because no orchard known to me is sufficiently infested to authorize the expense required to supply the necessary outfit.

"A modification of it, however, shold be adopted by the nurseries. All stock infested or suspected of infestation should be fumigated before being sent out. The trees should be either heeled in or made up in bundles, the roots wrappedto retain moisture, and the mass, covered by oiled canvas or other gas-tight material, should be fumigated one hour. The material should be used at the rate given—*i. e.*, one ounce of cyanide to one hundred and fifty cubic feet of space.

RECOMMENDATIONS.

"On consideration of all that has been said above, concerning life history and available remedies, the following suggestions for practice are made:

"*First.* Every orchard that has been set out within the last **six years** should be thoroughly examined to ascertain whether or not the scale is present.

"*Second.* If it proves to be present and is confined to a few trees, the trees had better be taken out and destroyed, unless the infestation is so slight that the trees can be gone over with a stiff brush and all the scales actually brushed off.

"*Third.* If the orchard is young, and the trees are not too large to be handled, it will be best to use a stiff brush and, taking each tree separately, brush off all the scales. This looks like a good deal of mechanical work; but it will be pay in the end. It can be done at any time during the winter; it will be absolutely effective and, with care, there need be no further trouble from this insect in an orchard so treated.

"*Fourth.* If the trees are too numerous to be treated by hand, or are too large to be conveniently handled, prune back liberally, removing as much wood as the tree can easily spare. The cuttings should be carted off and burnt as a matter of precaution, and what remains of the trees should be washed with the potash solution above described. This should be done as soon as may be, and a month later, during a moderately mild spell, the trees should be again treated, this time with the kerosene emulsion, made as above described and diluted five times. The object of this double treatment is, first, by means of the potash to dissolve or corrode the scales to a greater or less extent, and to kill off a considerable proportion of the insects themselves. At the end of a month the potash will probably have been washed down and all dissolved away, so as to exert no further action. The scales, however, will be thinned down, riddled or loosened from their hold, and an application of the kerosene emulsion then made will give it abundant opportunity to reach the insect. If both these materials are applied thoroughly, the kerosene will finish any work left undone by the potash and not a single specimen need escape.

"*Fifth.* Large or bearing trees should be treated much as described under the previous heading—that is to say, they should be cut back as far as it is possible to do without endangering the tree. If the bark of the tree is rough, it should be first scraped in order to get rid of all loose material. Then the potash should be applied, and afterward the kerosene emulsion, as described under the previous heading. Properly carried out, these recommendations should enable any orchardist to rid his trees completely, not only of San José, but of all other scale insects infesting his orchards.

"In place of the suggestions above made, the whale-oil soap treatment, described in a previous paragraph, may be adopted; but this also should be applied twice in order to make it certainly effective.

"All these recommendations are, of course, for winter treatment, when there is no foliage to interfere with the application of the material. If for any reason winter treatment is not possible, then spring treatment should be delayed until the young larvæ are observed crawling about. The kerosene emulsion should then be used, diluted with nine parts of water, and the spraying should be thorough. Two additional sprayings should be made at intervals of not more than a week, in order to kill off the young that are continually hatching, and to destroy the young scales that have just set. Three such applications, properly made, should be effective, and should be all that is necessary; but if young larvæ are again noticed later on, and it is evident that scales are still alive, the application should be repeated as often as may be necessary until no further larvæ are seen on the tree. I would again, however, urge most strongly immediate attention to orchards, and the winter treatment above outlined. The trees when dormant will stand a great deal more than when they are active, while the insects are not more resistant than they are during the summer. Applications, therefore, that are impossible in summer can be readily made in winter, and the winter treatment is not only more effective, but is on the whole cheaper.

"This scale is in some respects the most important insect that has been introduced into our State within recent years. Its wide range of food plants, its marvelous powers of multiplication, and its deadly effect upon the infested trees, all make it a pest of the first rank. No farmer ought to consider the matter unimportant enough to neglect, even though he has only a single tree. It is, I think, still possible to exterminate this insect in our State, and by care to prevent its re-introduction, and this leads me to my last, which was also my first, recommendation; carefully and thoroughly examine every tree and every shrub received from nurseries before setting them out, and whenever anything suspicious is noticed reject the stock rather than put it into the field, and run the risk of losing not only that which has been just planted, but also everything else that may be in the vicinity."

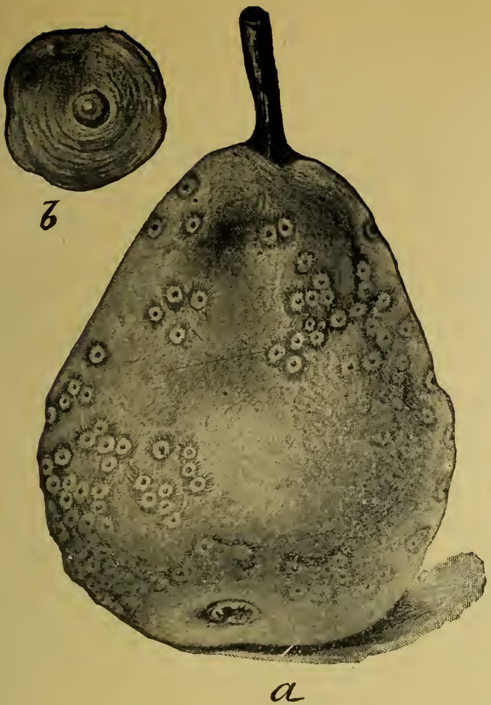

Fig. 1.
San José Scale.—*a*, California pear, moderately infested—natural size; *b*, female scale—enlarged.

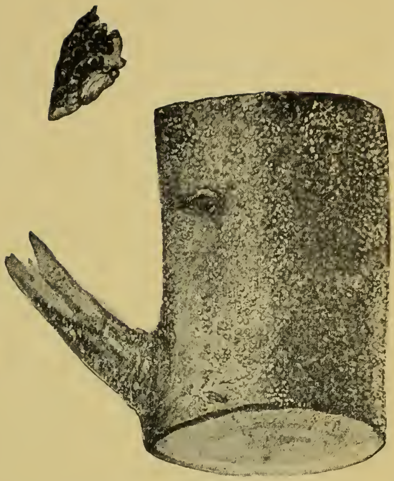

Fig. 2.
San José Scale.—Apple branch with scales *in situ*—natural size; enlarged scales above, at left

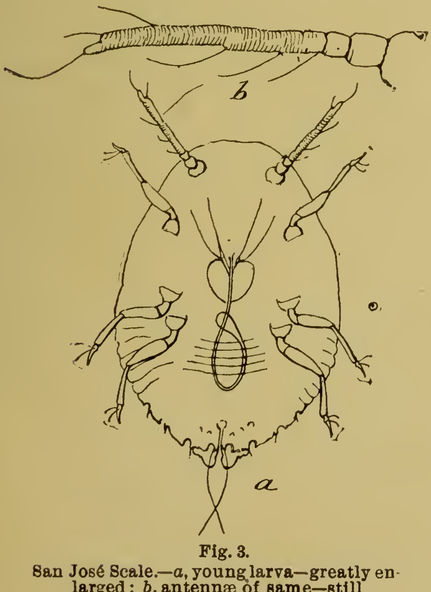

Fig. 3.
San José Scale.—*a*, young larva—greatly enlarged; *b*, antennæ of same—still more enlarged.

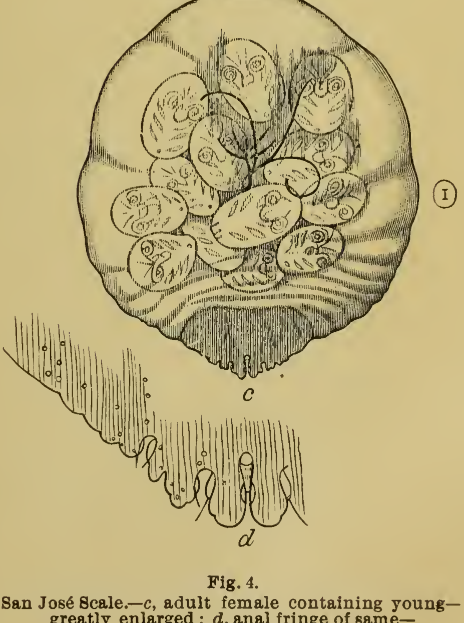

Fig. 4.
San José Scale.—*c*, adult female containing young—greatly enlarged; *d*, anal fringe of same—still more enlarged.

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BULLETIN

OF THE

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EXPERIMENTS WITH OATS.

BY J. FREMONT HICKMAN.

This Station has not published any of its work with oats since the spring of 1892. The results of the work done in 1892 were unavailable, for reasons given further on, therefore the experiments detailed and the data given in this bulletin include the work of only two years, 1893 and 1894. The several subjects treated will occur in the following order:

(1.) Comparison of varieties, 1893.
(2.) Comparison of varieties, 1894.
(3.) Percentage of hull and kernel.
(4.) Shrinkage in grain and straw.
(5.) Distribution of seed.
(6.) Methods of seeding.
(7.) Some points regarding smut.

In addition to the above, experiments have been conducted each year with commercial manures; these, however, are published with similar work on corn and wheat, in a separate bulletin.

1. COMPARISON OF VARIETIES, 1893.

Owing to the almost incessant rains of April and to the unfinished condition of the drainage of the experiment plots, the seeding of the oats in the spring of 1893 was delayed until the eighth and ninth days of May. From such late seeding not even a fair crop of oats could be expected. This afforded an opportunity for testing the several varieties under adverse conditions, which, as is indicated by the following tables, has not been work entirely wasted.

In these tables the sixty-four sorts grown are divided into groups, each having some distinctive characteristic.

The first group embraces sixteen differently named sorts, having the open or spreading panicle, coarse, weak straw, and short, plump grain of which the Welcome is the best known type. The second group comprises fourteen kinds, in which the head or panicle is more or less one-sided, and which are ordinarily termed side-oats. The Seizure is one of the best representatives of this class. A third group consists of eighteen varieties which are in general form similar to the Welcome class, except that the berry is longer and more pointed, and the straw generally a little stronger, but the grain lighter. We have chosen the Wideawake as the type of this class. In the fourth and last group are six sorts of black or mixed oats, having in the main the characteristics of the Welcome; in this group are included the Monarch, Rust Proof, and others of like kind.

The highest yield in the Welcome group is 39.8 bushels from the variety called Lincoln, which is followed closely by White Victoria and White Bonanza, each of which has given a yield slightly above 37 bushels per acre. The lowest in this group is 26 bushels from one of the twelve duplicate plots of Welcome; the average of this class is 30.3 bushels per acre, and the average of the Welcome duplicates in the group is 26.9 bushels. Leaving out these duplicate plots the group gives an average of 32.4 bushels to the acre.

The mixed group stands next highest in point of yield, and shows a variation in production running from 24.5 to 35.5 bushels to the acre.

The other two groups have averaged three days later in ripening, and show similar lower yields, as a result of late maturing. Some of these varieties, such as Seizure, Dakota Gray, Black Prolific and Prince Edward's Island, failed to properly mature; the result being a large number of heads, poorly filled with light grains, which blew over when threshed. These varieties suffered more than any others from the short season, followed by the extreme drouth of the maturing period.

The yields of this season (1893) cannot be taken as conclusive evidence of the fitness of any variety for the clay soils of Ohio. They simply indicate that certain varieties will do much better under the adverse conditions of late planting, excessive wet in the earlier and extreme drouth in the later oat season. In the Welcome group we have the following varieties yielding above thirty-three bushels: White Bonanza, White Wonder, Drogheda, Badger Queen, Improved American, Lincoln and American Banner.

In the side-oats group, only three varieties produced above thirty bushels, namely: Excelsior, White Swiss and Japan. This class has been in former years, with longer seasons and on a warmer, gravelly soil, the most productive group of the four. The typical variety of this class (Seizure), recognized as one of the best of its kind, gave the lowest yield of all the sixty-five varieties this year where it was sown late, yielding only about fifteen bushels to the acre. The evidence that this low yield was due to late seeding is found by comparing the yields given above with those in Table VIII, under "methods of planting." These plots were put out at least five weeks earlier, and show yields ranging from 32 to 40 bushels more to the acre.

For more specific facts regarding the experiment of 1893, the reader is referred to Table I, in which will be found the yield of each individual variety both in grain and straw, the pounds in a measured bushel of each, the color of grain and the date of maturing:

OATS.—TABLE I—Comparative Test of Varieties for 1893.

Plot No.	Varieties.	Yield per acre.			Weig't per measured bushel	Color of grain.	Date of ripening.
		Grain.	Straw.	Increase + decrease —			
	Welcome Group.	*Bushels.*	*Pounds.*	*Bushels.*	*Pnds.*		
1	Welcome	24.84	1,465	....	33.0	White.	July 31
2	American Banner	35.15	1,635	+10.13	29.0	"	" 31
3	Improved American	35.78	1,455	+10.58	30.0	"	Aug. 3
4	Welcome	25.40	1,615	....	33.0	"	July 31
5	Badger Queen	33.59	1,245	+7.65	32.7	"	" 31
6	Barley Oats	28.90	2,035	+2.43	31 2	"	" 31
7	Welcome	27.00	1,655	....	33.0	"	" 31
8	Colonel	32.84	1,925	+5.54	30.5	"	" 31
9	Clydesdale	27.68	1,555	+1.08	29.0	"	" 31
10	Welcome	26.40	1,475	....	33.0	"	" 31
11	Hargett's White	30.15	1,835	+4.88	41.2	"	" 28
12	Henderson's Clydesdale	28.28	1,295	+3.18	38.5	"	" 31
13	Welcome	24 53	1,495	....	33.0	"	" 31
14	Centennial	28.28	1,335	+3.33	33.0	"	" 31
15	Race Horse	27.65	1,793	+2.28	38.5	"	" 31
16	Welcome	25.79	1,655	....	33.0	"	" 31
17	White Belgian	30.78	1,695	+4.66	29.7	"	Aug. 4
18	White Bonanza	37.96	1,885	+11.51	36.0	"	July 31
19	Welcome	26 78	1,815	....	33.0	"	" 31
20	White Wonder	37.03	1,855	+10.25	39.5	"	" 31
21	White Victoria	31.40	1,715	+4.62	35.5	"	" 31
22	Welcome	26.77	1,853	....	33.0	"	" 31
23	Early Archangel	32.96	1,903	+4.91	40.0	"	" 31
24	Exelsior	31.09	2,265	+1.66	35.3	"	Aug. 2
25	Welcome	30.62	1,600	....	33.0	"	July 31
26	Drogheda	33.12	2,000	+2.19	37.5	"	" 31
27	Lincoln	39.84	2,105	+8.60	30 5	"	" 31
28	Welcome	31.56	1,650	....	33.0	"	" 31
29	White Swiss	31.71	1,985	+0.21	35.0	"	Aug. 3

OATS.—TABLE I—Continued.

Plot No.	Varieties.	Yield per acre.			Weig't per measured bushel	Color of grain.	Date of ripening.
		Grain.	Straw.	Increase + decrease —			
	Seizure Group.	*Bushels.*	*Pounds.*	*Bushels.*	*Pnds.*		
30	Seizure	13.40	1,607	....	29.0	White.	Aug. 3
31	Early Swedish	29.68	2,350	+16.08	34.5	"	" 3
32	Japan	35.46	2,185	+21.66	35.0	Black.	" 3
33	Seizure	14.00	1,927	....	29.0	White.	" 3
34	Wilson's Prolific	35.31	2,050	+21.31	31.0	"	" 3
35	Dakota Gray	22.65	1,795	+8.65	27.0	Black.	" 3
36	Seizure	14.00	1,772	....	29.0	White.	" 3
37	Prince Edward's Island	26.25	1,940	+11.84	31.0	"	" 3
38	Black Prolific	27.97	2,305	+13.15	29.0	Black.	" 3
39	Seizure	15.22	1,592	....	29.0	White.	" 3
40	Golden Giant	17.25	1,430	+1.25	25.8	Yellow.	" 3
41	Giant Yellow French	18.20	1,557	+1.42	25.0	"	" 3
42	Seizure	17.57	1,577	....	29.0	White.	" 3
43	Black Tartarian	23.59	1,605	+6.02	29.0	Black.	" 3
44	Egyptian	31.71	1,700	+14.14	37.0	White.	" 3
	Wideawake Group.						
45	Wideawake	28.90	1,850	....	28.5	White.	Aug. 8
46	Black Norway	21.01	1,232	—8.86	29.7	Black.	" 6
47	Alabama	22.73	1,112	—7.11	31.7	Red.	" 3
48	Wideawake	30.31	1,170	....	28.5	White.	" 3
49	Banner	26.09	1,265	—4.06	29.0	"	" 3
50	White California	21.64	1,487	—8.35	31.2	"	" 2
51	Wideawake	29.84	1,185	....	28.5	"	" 3
52	Early Prize Cluster	29.22	1,385	—0.72	34.5	"	" 3
53	Scottish Chief	25.15	1,275	—4.89	34.2	"	" 3
54	Wideawake	30.15	1,115	....	28.5	"	" 3
55	Currie's Prize Cluster	31.40	995	+1.67	34.0	"	" 3
56	Hopetown	16.73	1,265	—12.58	30.0	"	" 6
57	Wideawake	28.90	1,195	....	28.5	"	" 3
58	Kansas Hybrid	38.59	1,125	+8.86	37.2	"	" 3
59	Pringle's Progress	25.46	985	—5.10	31.0	"	" 3
60	Wideawake	31.40	1,675	....	28.5	"	" 3
61	Probsteier	27.65	1,475	—2.98	32.2	"	" 3
62	State of North Dakota	32.03	1,815	+2.17	31.5	"	" 3
63	Wideawake	29.09	1,085	....	28.5	"	" 3
64	Welch	17.65	1,515	+11.15	29.0	"	" 8
65	Yankee Prolific	43.28	2,215	+14.78	30.0	"	" 3
66	Wideawake	28.20	1,018	....	28.5	"	" 3
67	Potato Oats	23.20	1,157	—5.00	33.7	"	" 3
68	White Bedford	24.60	912	—3.60	39.0	"	July 31
69	Wideawake	28.20	1,497	....	28.5	"	Aug. 3
70	Early Dakota	29.21	1,305	+0.24	30.2	"	" 3
71	White Canadian	30.46	1,305	+0.71	31.2	"	" 3
72	Wideawake	30.53	1,295	....	28.5	"	" 3
73	Poland	34.21	1,405	+3.86	30.5	"	" 3
74	Early White Maine	30.46	1,285	+0.29	29.5	"	" 3
75	Wideawake	30.00	1,220	....	28.5	"	" 3
76	New Baltic	33.75	1,120	+3.75	32.2	"	" 3
77	Pringle's American Triumph	27.06	1,123	—2.04	28.5	"	" 3

OATS.—TABLE I—Concluded.

Plot No.	Varieties.	Yield per acre.			Weig't per measured bushel	Color of grain.	Date of ripening.
		Grain.	Straw.	Increase + decrease —			
	Wideawake Group—Conclud'd.	*Bushels.*	*Pounds.*	*Bushels.*	*Pnds.*		
78	Great Northern	30.78	1,255	+0.78	33.0	White.	Aug. 3
79	White Russian..................	26.56	1,430	—3.44	31.5	"	" 3
80	American Beauty	29.21	1,245	—0.79	31.0	"	" 3
81	White Schoenen................	33.43	1,270	+3.43	31.5	"	" 3
82	White Superior Scotch.......	23.12	1,320	—6.88	38.0	"	July 31
	Mixed Group.						
83	Monarch	34.06	2,130	+9.53	32.5	Mixed.	July 28
84	Rust Proof......................	31.25	2,120	+6.72	30.5	Red.	" 28
85	Welcome	24.53	1,695	....	33.0	White.	" 31
86	New Red Rust Proof..........	26.26	1,380	+1.23	28.5	Mixed.	" 31
87	Black Russian	28.43	1,310	+2.90	30.0	Black.	" 31
88	Welcome	26.04	1,430	....	33.0	White.	" 31
89	Everitt's Negro Black.........	34.22	1,450	+8.18	33.0	Black.	" 31
90	Black Beauty	35.62	1,520	+9.58	32.5	"	" 31

2. COMPARISON OF VARIETIES, 1894.

The sowing of the oats in 1894 was done much more seasonably than in the previous year. A large part of the ground was plowed before the middle of March, and the oats were all in the ground by the evening of the 16th of April. Table II gives for 1894 similar data to those given in Table I for 1893.

The third column in each of these tables represents the increase or decrease in yields of each variety as compared with the neighboring plots of the variety used as a check or standard. In calculating this increase or decrease it is assumed that the variation in soil between neighboring check plots is progressive; for instance, the yield of plot 1 being 42.3, and plot 5 being 44.5, it is assumed that if plots 3, 4 and 5 had been sown with the same variety of oats the yields of these three intermediate plots would have been 42.86, 43.42 and 43.97 bushels respectively.

By this method of making comparison we find that of the other 20 varieties in the Welcome group, only three have produced more than the nearest Welcome plot, namely, Improved American, Badger Queen and Bonanza King.

Making further comparison of Tables I and II, we find the average yield of the Welcome group in 1893 was 30.38 bushels, the average of the same number of varieties for 1894 in the same group, was 40.65 bushels. The average of the group without the Welcome duplicates in 1893 was 32.40 bushels, in 1894, 39.85. The Welcome duplicates in 1893 averaged 26.96 bushels per acre, and in 1894, 42.94 bushels.

In the Seizure group, we find about one-half of the varieties producing larger yields and the other half smaller returns than the standard of the group. In 1893 not a single variety did as poorly as the Seizure.

The average yield of this group for 1893 was 23.16 bushels, and for 1894, 44.05 bushels—almost double that of the previous year. The duplicate plots in 1893 gave an average yield of 15.02, and in 1894, an average of 44.46 bushels, almost treble the yield of the preceding year.

Like variations in yield are shown in the Wideawake group, but the differences are not so marked in the mixed group.

The average of the straw per acre in 1893 was as follows: Welcome group, 1,653 pounds; Seizure group, 1,830 pounds; Wideawake group, 1,266 pounds, and the mixed group, 1,629 pounds. In 1894 the average of the straw per acre in the several groups was as follows: Welcome, 1,684; Seizure, 1,779; Wideawake, 1,219, and the mixed, 1,034 pounds.

Pounds of straw per hundred pounds grain in 1893, Welcome, 170; Seizure, 246; Wideawake, 138, and the mixed group, 169 pounds. In 1894, Welcome group, 129 pounds to each one hundred pounds of grain; Seizure, 126; Wideawake, 105, and the mixed group, 89 pounds.

Since our system of grouping is dependent in part upon the manner of growth of each variety, it is not always possible to place new varieties in their proper group until after we have had them growing one year. This accounts for an occasional changing of a variety from one group to another.

OATS.—TABLE II—COMPARATIVE TEST OF VARIETIES FOR 1894.

Plot No.	Varieties.	Yield per acre.			We'g't per bushel	Color of grain.	Date of ripening.
		Grain.	Straw.	Increase + decrease —			
	Welcome Group.	*Bushels.*	*Pounds.*	*Bushels.*	*Pnds*		
1	Welcome	42.3	1,845	....	31.46	White.	July 20
2	American Banner	39.2	1,595	—3.65	29.50	"	" 22
3	Improved American	46.8	1,802	+3.40	30.00	"	" 22
4	Badger Queen	46.1	1,675	+2.05	34.25	"	" 22
5	Welcome	44.5	1,775	....	31 46	"	" 20
6	Barley Oats	44.5	1,675	—0.62	32.05	"	" 19
7	Colonel	44.5	1,825	—1.24	32.75	"	" 20
8	Clydesdale	44.5	1,525	—1.87	31.25	"	" 20
9	Welcome	42.0	1,810	....	31 46	"	" 20
10	Hargett's White	37.6	1,495	—4.10	37.50	"	" 18
11	Henderson's Clydsedale	40.1	1,615	—1.30	37.50	"	" 20
12	Centennial	40.0	1,620	—1.10	33.50	"	" 20
13	Welcome	40.8	1,745	....	31.46	"	" 20
14	Race Horse	26.4	1,895	—14 70	38.00	"	" 20
15	White Belgian	40.8	1,495	—0.75	31 75	"	" 21
16	White Bonanza	40.8	1,795	—1.12	37.50	"	" 18
17	Welcome	42.3	1,745	....	31.46	"	" 20
18	White Wonder	38.8	1,710	—4.12	39.00	"	" 18
19	White Victoria	43.1	1,705	—0 45	33.50	"	" 20
20	Early Archangel	37.6	1,645	—6.57	37.00	"	" 20
21	Welcome	44.8	1,815	....	31.46	"	" 20
22	Drogheda	36.8	1,520	—7.77	34 75	"	" 18
23	Lincoln	33.2	1,485	—11.15	32.50	"	" 26
24	Heavy Weight	39.2	2,045	—4.92	31.00	"	" 26
25	Welcome	43.9	1,595	....	31.46	"	" 20
26	Pride of America	32.5	1,310	—11.40	34.50	"	" 20
27	Bonanza King	44.5	1,725	+0.60	31.00	"	" 24
	Seizure Group.						
28	Seizure	43.2	1,915	....	26.00	White.	July 26
29	Excelsior	44.2	1,735	+0.82	35.25	"	" 24
30	White Swiss	46.2	1,772	+2.65	35.00	"	" 24
31	Early Swedish	49.1	1,875	+5.37	36.25	"	" 24
32	Seizure	43.9	1,945	....	26.00	"	" 26
33	Japan	49.8	1,708	+5.60	35.50	Black.	" 28
34	Wilson's Prolific	46.6	1,807	+2.10	34.25	White.	" 28
35	Dakota Gray	41.8	1,812	—3.00	32.25	Black.	" 28
36	Seizure	45.1	1,905	....	26.00	White.	" 26
37	Prince Edward's Island	46.9	1,800	+1.62	31.25	"	" 28
38	Black Prolific	44.8	1,415	—0.65	29 50	Black.	" 28
39	Golden Giant	38.3	1,625	—7.32	29.25	Yellow.	" 28
40	Seizure	45.8	1,835	....	26.00	White	" 26
41	Giant Yellow French	36.9	1,470	—8.52	28.25	Yellow.	" 28
42	Black Tartarian	38.6	1,665	—6.45	29 75	Black.	" 28
43	Egyptian	44.8	1,815	+0.13	37.25	White.	" 27
44	Seizure	44.3	1,982	....	26 00	"	" 26
45	Black Norway	41.7	1,865	—2.60	31.00	Black.	" 28
46	Mammoth Cluster	45.0	1,860	+0.70	31.00	"	" 28

OATS.—TABLE II—Concluded.

Plot No.	Varieties.	Yield per acre.			We'g't per bushel	Color of grain.	Date of ripening.
		Grain.	Straw. Pounds.	Increase + decrease —			
	Wideawake Group.	*Bushels.*	*Pounds.*	*Bushels.*	*Pnds.*		
47	Wideawake......	45.1	1,605	....	30.00	White.	July 23
48	Alabama..	50.3	1,590	+5.50	31.50	“	“ 23
49	Banner	43.6	1,605	—0.30	29.00	“	“ 24
50	White California...............	45.9	1,580	+2.60	31.25	“	“ 23
51	Wideawake......................	42.7	1,485	....	30.00	“	“ 23
52	Early Prize Cluster...........	40.8	1,295	—1.22	32.75	“	“ 23
53	Scottish Chief..................	39.0	1,300	—2.35	33.00	“	“ 23
54	Currie's Prize Cluster.........	40.9	1,490	+0.22	32.50	“	“ 23
55	Wideawake......................	40.0	1,370	....	30.00	“	“ 23
56	Hopetown	29.4	1,360	—10.25	31.50	“	“ 26
57	Kansas Hybrid..................	41.1	1,185	+1.80	31.00	“	“ 21
58	Bolton	37.0	1,115	—1.95	28.50	“	“ 25
59	Wideawake......................	38.6	1,210	....	30.00	“	“ 23
60	Probsteier	44.5	1,375	+5.87	30.25	“	“ 23
61	State of North Dakota.........	39.5	1,135	+0.85	29.50	“	“ 23
62	Welch	22.7	975	—15.97	33.00	“	“ 23
63	Wideawake..	38.7	1,010	....	30.00	“	“ 23
64	Yankee Prolific.................	32.3	1,315	—5.97	28.75	“	“ 28
65	Potato Oats......................	37.0	1,365	—0.85	30.00	“	“ 23
66	White Bedford..................	32.3	865	—5.12	35.50	“	“ 20
67	Wideawake......................	37.0	1,305	....	30.00	“	“ 23
68	Early Dakota......................	34.5	1,195	—2.57	30.50	“	“ 23
69	Green Mountain................	33.9	1,115	—3.25	28.50	“	“ 25
70	Poland	31.0	1,155	—6.22	30.50	“	“ 24
71	Wideawake......................	37.3	1,155	....	30.00	“	“ 23
72	Early White Maine............	28.5	1,135	—8.27	29.50	“	“ 23
73	New Baltic	30.6	820	—5.65	29.50	“	“ 23
74	White Superior Scotch........	23.2	807	—12.52	34.75	“	“ 19
75	Wideawake......................	35.2	1,125	....	30.00	“	“ 23
76	Great Northern.................	28.9	975	—6.37	30.25	“	“ 23
77	White Russian	30.8	1,415	—4.55	29.00	“	“ 26
78	American Beauty..............	33.2	985	—2.22	30.00	“	“ 24
79	Wideawake......................	35.5	1,115	....	30.00	“	“ 23
80	White Schoenen..........	26.1	915	—9.40	29.00	“	“ 23
	Mixed Group.						
81	Calgary Gray....................	38.6	1,165	+3.30	32.00	Black.	July 23
82	Black Prolific.............. ...	44.8	1,415	+9.50	29.50	“	“ 28
83	Monarch	35.3	1,020	....	32.25	Mixed	“ 24
84	Australian Giant...............	34.5	1,295	—0.80	29.25	... .	“ 27
85	Rust Proof	35.5	715	+0.20	31.25	Red.	“ 24
86	Black Russian..................	32.6	905	—2.90	30.00	Black.	“ 24
87	Monarch	35.5	965	....	32.25	Mixed.	“ 24
88	Everitt's Negro Black.........	33.3	1,035	—2.20	30.50	Black	“ 23
89	Black Beauty....................	34.5	945	—1.00	31.25	“	“ 23
90	New Red Rust Proof..........	30.1	885	—5.40	31.00	Mixed	“ 23

Table III gives the yield of each variety, and the average yield for four years of the several varieties that have been grown on the Station grounds during the season of 1890 and since that time. This table discloses the following facts:

The Improved American gave the highest yield of any of the Welcome group in 1894, and the same variety has produced on an average nearly four bushels more per acre than any other in that group.

The Japan variety has given the highest yield of any of the Seizure group in 1894, and has as high an average yield as any other member of the group.

The Kansas Hybrid stands as high in the average as any in the Wideawake group, but the Alabama has given the highest yield during the season of 1894, not only in this particular group, but the highest, considering all varieties in the test.

Japan and Early Swedish, belonging to the Seizure group, gave yields almost equal to the Alabama.

Taking the oats by classes we find that the Seizure class gives for the series of years an average of 37.8 bushels; the Welcome, 35.1; the Wideawake, 34 5; and the mixed group, 34.1 bushels per acre.

Table IV gives the weight per measured bushel of all the varieties given in Table III for each year of the four in which they were under test. The average weight per measured bushel for the several classes is as follows: Welcome, 32.7; Seizure, 30.7; Wideawake, 30.7, and the mixed class, 30.0 pounds per bushel. For more specific data see Table IV.

OATS.—TABLE III—AVERAGE YIELD FOR FOUR YEARS, 1890-94.

Variety.	Yield in bushels per acre.				
	1890.	1891.	1893.	1894.	Average
Welcome Group.					
Welcome	18.7	46.2	24.8	42.3	33.0
Improved American	83.7	56.2	35.7	46 8	43.1
Badger Queen	19.0	45.3	33.6	46.1	35.9
Barley Oats	21.2	51.8	28.9	44.5	36.6
Colonel	29.6	50.9	32.3	44.5	39.3
Clydesdale	17.1	46.2	27.6	44.5	33.8
Hargett's White	16.5	43.4	30.1	37.6	31.9
Henderson's Clydesdale	16.2	40.3	28.2	40.1	31.2
Centennial	20.6	46.2	28.2	40.0	33.7
Race Horse	26.8	39.0	27.6	26.4	29.9
White Belgian	29.3	46.2	30.7	40.8	36.7
White Bonanza	15.0	42.5	37.9	40.8	34.0
White Victoria	27.5	49.3	31.4	43.1	37.8
Average of group	....	....	....	....	35.1

OATS.—TABLE III—Concluded.

Variety.	Yield in bushels per acre.				
	1890.	1891.	1893.	1894.	Average
Seizure Group.					
Seizure	17.6	56.1	14.8	44.4	33.2
Early Swedish	27.1	56.2	29.6	49.1	40.5
Japan	20.9	56.2	35.4	49.8	40.6
Wilson's Prolific	18.4	51.5	35.3	46.6	37.9
Dakota Gray	33.4	60.3	22.6	41.8	39.5
Prince Edward's Island	24.0	63.1	26.2	46.9	40.0
Black Prolific	20.6	61.2	27.9	44.8	38 6
Golden Giant	24.3	57.5	17.2	38.3	34.3
Giant Yellow French	26.2	57.8	18.2	36.9	34.8
Black Tartarian	32.8	61.8	23.5	28.6	36.7
Egyptian	28.1	54.3	31.7	44.8	39.7
Average of group	....	....	....	....	37.8
Wideawake Group.					
Wideawake	31.8	51.8	29.6	38.9	38.0
Alabama	31.2	46.8	22.7	50.3	37.7
Banner	20.4	51.2	26.1	16.0	28.4
White California	29.6	53.7	21.6	45.9	37.7
Early Prize Cluster	26.2	47.5	29.2	40.8	35.9
Scottish Chief	29.3	53.1	25.1	39.0	36.6
Currie's Prize Cluster	17.5	48.1	31.4	40.9	34 4
Hopetown	20.3	36.5	16.7	29.4	25 7
Kansas Hybrid	30.6	48.7	38.5	41.1	39.7
Probsteier	29.3	53.1	27.6	44.5	38.6
State of North Dakota	33.1	52.5	32.0	39 5	39.2
Welch	23.1	38.1	17.6	22.7	25.3
Yankee Prolific	26.5	41.8	43.2	32.3	35.9
Potato Oats	28.9	39.3	23.2	37.0	32.1
Early Dakota	32.3	51.8	29.2	34.5	36.9
White Russian	27.1	41.8	26.5	30.8	31.5
White Schoenen	27.8	45.0	33.4	26.1	33.0
Average of group	....	....	....	....	34.5
Mixed Group.					
Monarch	32.1	50.0	34.0	35.3	37.8
Black Russian	25.3	44.0	28.4	32.6	32.5
Rust Proof	21.7	57.8	31.2	35.5	36.5
New Red Rust Proof	25.9	37.1	26.2	30.1	29.8
Average of group	....	....	....	....	34.1

OATS.—TABLE IV—WEIGHT PER BUSHEL FOR FOUR YEARS, 1890-94.

Varieties.	Weight per bushel in pounds.				
	1890.	1891.	1893.	1894.	Average
Welcome Group.					
Welcome	29.2	33.0	33.0	31.4	31.6
Improved American	29.0	30.0	30.0	30 0	29.7
Badger Queen	27.0	35.0	32.7	34.2	32.2
Barley Oats	25.7	32.0	31.2	32.0	30.2
Colonel	29.5	30.0	30.5	32.7	30.7
Clydesdale	28.2	37.0	29.0	31.2	31.3
Hargett's White	37.7	38.0	41.2	37.5	38.6
Henderson's Clydesdale	28.7	32.0	38.5	37.5	34.2
Centennial	32.7	31.0	33.0	33.5	32.5
Race Horse	33.7	32.0	38 5	38.0	35 5
White Belgian	30.0	29.0	29.7	31.7	30.1
White Bonanza	30.7	37.0	36.0	37.5	35.3
White Victoria	30.5	34.0	35.5	33.5	33.4
Average of group					32.7
Seizure Group.					
Seizure	27.2	29.0	26.0	29.0	27.8
Early Swedish	34.5	33.0	34.5	36.2	34.5
Japan	35.2	32.0	35.0	35.5	34.4
Wilson's Prolific	27.7	31.0	31.0	34.2	30 9
Dakota Gray	24.7	28.0	27.0	32.2	27.9
Prince Edward's Island	29.2	31.0	31.0	31.2	30 6
Black Prolific	31.0	31.0	29.0	29.5	30.1
Golden Giant	28.0	28.0	25.8	29.2	27.7
Giant Yellow French	27.0	29.0	25.0	28.2	27.3
Black Tartarian	30.0	29.0	29.0	29.7	29.4
Egyptian	37.5	35.0	37.0	37.2	36.7
Average of group					30.7
Wideawake Group.					
Wideawake	27.5	29.0	28.5	30.0	28.7
Alabama	29.7	31.0	31.7	31.5	30.9
Banner	30.5	28.0	29.0	29.0	29.1
White California	30.5	29.0	31.2	31.2	30.5
Early Prize Cluster	31.3	31.0	34.5	32.7	32.4
Scottish Chief	32.7	32.0	34.2	33.0	32 9
Currie's Prize Cluster	35.2	32 0	34.0	32.5	33.4
Hopetown	27.7	31.0	30.0	31.5	30.0
Kansas Hybrid	30.2	32.0	37.2	31.2	32.6
Probsteier	29.7	30.0	32.2	30.2	30.5
State of North Dakota	29.0	31.0	31.5	29.5	30.2
Welch	32.2	31.0	29.0	33 0	31.3
Yankee Prolific	30.7	30.0	30.0	28.7	29.8
Potato Oats	30.2	29.0	33.7	30.0	30.7
Early Dakota	30.7	31.0	30.2	30.5	30.6
White Russian	29.5	28.0	31.5	29.0	29.5
White Schoenen	27.5	31.0	31.5	29.0	29.7
Average of group					30.7

OATS.—TABLE IV—Concluded.

Varieties.	Weight per bushel in pounds.				
	1890.	1891.	1893.	1894.	Average
Mixed Group.					
Monarch	31.5	31.0	32.5	32.2	31.8
Black Russian	30.0	31.0	30.0	30.0	30.2
Rust Proof	29.2	30.0	30.5	31.2	30.2
New Red Rust Proof	27.5	25.0	28.5	31.0	28.0
Average of group					30.0

3. PERCENTAGE OF HULL AND KERNEL.

Frequently the question is asked, "does not the oats that weighs heaviest to the measured bushel have a smaller proportion of hull than the lighter oats?" This question can only be solved by a careful investigation. This work was begun on the crop of 1894. Five grammes of each variety were counted and hulled, the hulls and kernels were each weighed separately, and from the weights thus gotten the percentages were calculated; these are given in Table V. The careful observer will notice that in nearly every case the total percentage falls from one-half to one per cent. below the even one hundred. The uniformity of these results seems to indicate that the percentages given, while not absolutely correct, must certainly be within one per cent. of the truth, and this is certainly within a reasonable limit. Scanning Table V, we find the widest variation in percentage of kernel is between Race Horse, which has 75.4 per cent., and Green Mountain, which has but 64.2 per cent., or a difference of 11.2 per cent.

Taking the Welcome group, and dividing it into three divisions, it is found that the average weight per measured bushel of the six heaviest varieties is 37.75 pounds; the average per cent. of kernels in these six is 71.2. In the eight varieties, the weight per measured bushels of which ranges between 32 and 35 pounds, the average is found to be 33.5 pounds and the average per cent. of kernels is 70.2. The other thirteen varieties range from 29.5 to 31.7 pounds per measured bushel, and average 31.1 pounds; the per cent. of kernel is found to average 67.6.

These figures seem to indicate that the heavier the oats, the larger the percentage of kernel and the smaller the percentage of hull; but if we examine the Seizure group on a similar plan, we get a different result, as follows: Four varieties, averaging over 36 pounds to the bushel, give an average of 68 per cent. of kernel; three varieties, averaging 33.8 pounds per bushel, give an average of 67 per cent. of kernel, and seven varieties, averaging 30 pounds to the bushel, give an average of 69 per cent. of kernel. Again, if we take some individual varieties of extremely light weight, we find that the percentage of kernel is much higher than it is in some of those that weigh much more to the measured bushel. We can only infer from the work thus far that weight per measured bushel is not necessarily a safe guide to follow in order to secure a large percentage of kernel.

OATS.—TABLE V—PERCENTAGE OF HULL AND KERNEL OF GRAIN AND SHRINKAGE OF GRAIN.

Varieties.	No. of grains in five gr'ms.	Hull.	Kernel.	Weight in September.	Weight in March.
Welcome Group.		*Per cent.*	*Per cent.*	*Pounds.*	*Pounds.*
Welcome	237	33.0	67.0	102.5	102.0
American Banner	218	34.0	66.0	57.0	57.0
Improved American	212	32.5	67.5	....	....
Badger Queen	230	26.9	73.1	54.5	53.5
Barley Oats	242	27.2	72.8	47.0	46.5
Colonel	241	28.4	71.6	52.5	52.5
Clyde-dale	249	29.8	70.2	61.0	59.5
Hargett's White	189	30.8	69.2	49.0	48.0
Henderson's Clydesdale	210	30.3	69.0	46.0	46.0
Centennial	233	29.4	70.3	46.0	45.5
Race Horse	221	24.6	75.4	45.0	45.0
White Belgian	218	29.4	69.6	50.0	50.0
White Bonanza	218	28.2	71.5	61.5	61.5
White Wonder	186	31.1	68.1	60.0	60.0
White Victoria	216	29.4	70.4	102.0	102.0
Early Archangel	225	24.9	74.2	107.0	107.0
Drogheda	198	30.2	69.2	107.5	107.0
Lincoln	200	32.6	66.4	129.0	127.5
Heavy Weight	235	33.0	66.2	....	....
Pride of America	197	31.2	68.2	....	....
Bonanza King	238	28.0	71.1	....	....
Average of group	219	29.7	69.8	....	....
Seizure Group.					
Seizure	238	....	....	28.0	26.5
Excelsior	233	31.4	67.6	101.0	101.0
White Swiss	226	31.7	67.3	....	....
Early Swedish	238	32.0	67.2	96.5	96.0
Japan	235	29.7	69.3	115.0	113.0
Wilson's Prolific	221	31.0	68.2	114.5	113.5
Dakota Gray	235	31.8	67.2	74.0	72.0
Prince Edward's Island	239	32.3	66.7	....	....
Black Prolific	258	29.6	69.4	91.0	89.0

OATS.—TABLE V—Concluded.

Varieties.	No. of grains in five gr'ms.	Hull.	Kernel.	Weight in September.	Weight in March.
Seizure Group—Concluded.		*Per cent.*	*Per cent.*	*Pounds.*	*Pounds.*
Golden Giant	233	28.8	70.7	....	....
Giant Yellow French	239	28.0	71.8	....	....
Black Tartarian	234	32.5	67.5	77.0	76.0
Egyptian	196	31.0	68.0	....	....
Black Norway	248	26.1	73.4	68.0	68.0
Mammoth Cluster	242	32.6	66.6	....	....
Average of group	234	30.6	68.6	....	....
Wideawake Group.					
Wideawake	227	30.4	69.6	112.0	111.5
Alabama	248	28.6	71.4	73.5	72.5
Banner	232	32.6	66.4	85.0	84.0
White California	250	30.2	68.9	70.0	68.5
Early Prize Cluster	243	28.6	70.8	47.5	46.5
Scottish Chief	237	30.2	68.8	41.0	40.0
Currie's Prize Cluster	233	28.6	70.4	51.0	51.0
Hopetown	214	28.4	71.0	27.5	26.0
Kansas Hybrid	247	30.3	68.8	62.5	62.0
Bolton	219	34.0	65.2	....	....
Probsteier	250	29.5	70.0	45.0	45.0
State of North Dakota	252	30.8	68.7	52.0	51.5
Welch	234	26.6	72.6	....	....
Yankee Prolific	253	31.2	69.0	70.0	69.5
Potato Oats	241	31.6	67.6	75.0	75.0
White Bedford	187	33.0	66.2	79.5	79.5
Early Dakota	262	28.5	71.2	95.0	95.0
Green Mountain	205	35.2	64.2	....	....
Poland	240	32.0	68.0	111.0	110.5
Early White Maine	234	31.9	67.6	99.0	96.0
New Baltic	219	32.0	66.3	109.0	109.0
White Superior Scotch	187	33.0	66.3	75.0	75.0
Great Northern	215	30.1	69.1	100.0	100.0
White Russian	242	32.6	66.6	....	....
American Beauty	214	32.6	66.6	95.0	95.0
White Schoenen	219	33.0	66.5	108.5	108.5
Average of group	231	30.9	68.3	....	....
Mixed Group.					
Calgary Gray	269	25.6	73.9	....	....
Black Prolific	258	29.6	69.3	....	....
Monarch	255	25.8	73.5	110.5	110.5
Rust Proof	262	26.8	72.6	101.5	101.5
Black Russian	253	27.4	71.9	92.5	92.5
Everitt's Negro Black	261	25.3	74.0	111.0	111.0
Black Beauty	259	29.8	69.7	115.5	115.5
New Red Rust Proof	236	27.4	72.6	85.5	85.5
Average of group	256	27.2	72.2	....	....

4. Shrinkage in Grain and Straw.

In September, 1893, sixty-five varieties of oats were cleaned and put into an empty room. Each sack bore a tag giving the name of the variety and also the number of pounds in the sack. The room was kept quite warm all winter, the temperature seldom, if ever, falling below fifty degrees. About the middle of March these sacks were weighed again, and the weights when put in and when taken out are given in Table V. The shrinkage was remarkably low, being less than one per cent. A number of the varieties were interfered with by mice; these were not weighed a second time, which accounts for the omission of the weights in the table.

Soon after threshing, the oats straw was packed into bales weighing from 90 to 140 pounds each; these were stored on an ordinary barn floor, and taken out, weighed and sold about the fifteenth of March. Three different lots were weighed with the following results: The first lot weighed when put in, 5,175 pounds, when taken out, 4,865 pounds; loss, 310 pounds, or 6 per cent.; the second lot when put in weighed 4,955 pounds, when taken out, 4,675 pounds, a loss of 280 pounds, or 5.7 per cent.; the third lot weighed when put in, 2,735 pounds, when taken out, 2,590 pounds, a shrinkage of 145 pounds, or 5.3 per cent.; making an average shrinkage on the three lots of 5.7 per cent.

5. Distribution of Seed.

On account of the removal of the Station in 1892, no experiments were made that year with different quantities of seed per acre. In the spring of 1893 a series of plots were prepared and put in, in the best possible condition, but owing to the lack of uniformity in drainage, the results from the duplicate plots showed plainly that the test was wholly unreliable.

In the spring of 1894 a block of twenty-four plots was put in; twelve of these were sown with the Welcome variety, and twelve with the Seizure. The results obtained at the thresher are given in Table VI, except from the ten, eleven and twelve-peck rates of seeding with the Welcome oats; these are not given because of the irregularities in soil, due to imperfect drainage, which vitiated the results.

The yields given in this table show practically the same results as a like experiment conducted on the warmer, gravelly soils of the Olentangy bottom at Columbus. Better returns are given from the six and seven-peck rate of seeding than from the higher or lower rate. The weight of the product per measured bushel is higher, with a single exception, from the six and seven-peck rate than from any other.

OATS.—TABLE VI—DISTRIBUTION OF SEED, 1894.

Seizure.				Welcome.			
Seed per acre.	Grain per acre.	Weight per measured bushel.	Straw per acre.	Seed per acre.	Grain per acre.	Weight per measured bushel.	Straw per acre.
	Bushels.	*Pounds.*	*Pounds.*		*Bushels.*	*Pounds.*	*Pounds.*
3 pecks.....	27.2	30.5	1,930	3 pecks ...	20.1	31.5	1,030
4 "	27.8	30.5	1,810	4 " ...	22.5	32.5	880
5 "	27.5	30.7	1,900	5 " ...	22.6	32.2	975
3 "	27.8	30.5	1,850	3 " ...	21.5	31.5	1,010
6 "	29.0	31.5	1,780	6 " ...	23.1	33 2	1,060
7 "	31.2	31.2	1,940	7 " ...	24.0	33.2	930
3 "	27.5	30.5	1,920	3 " ...	22.1	31.5	1,090
4 "	28.1	30.5	1,715	4 " ...	22.1	32.5	920
8 "	27.5	30.5	1,610	8 " ...	24.7	31.5	910
9 "	26.5	31.2	1,350	9 " ...	25.9	32.7	970
5 "	25.9	30.7	1,840	5 " ...	23.7	32.2	940
10 "	26.5	29.7	1,520				
11 "	28 4	30.2	1,390				
12 "	27.2	30.0	1,430				

The straw weights as given in all this work, are more or less deceptive. The table shows more straw from the lighter seeding than from the greater quantity, but I think this is nearly if not quite all due to the fact that there was a larger percentage of weeds in the sparingly seeded plots, whereas the ground was occupied with almost absolutely pure straw on the more densely seeded ones.

Table VII gives in condensed form the average results of five years' experiments in the distribution of seed. Four years of this work was conducted on the Columbus farm and the last one on the Wayne county farm. Previous work seemed to justify the conclusion that the range of oats seeding for the best returns was somewhere between the five and eight peck rate per acre; the experiment of the last year confirms that conclusion, and the average for a series of years gives further evidence, that well prepared ground, with well cleaned seed, will yield as good returns from six pecks of seed per acre as from five, seven or eight pecks, and that the quality of the grain will as a rule be as good as from the higher or lower rate of seeding.

OATS—TABLE VII—DISTRIBUTION OF SEED. SUMMARY FOR FIVE YEARS.

Seed per acre.	Yield of grain per acre.					
	1888.	1889.	1890.	1891.	1894.	Average.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels*	*Bushels.*
4 pecks....................	57.7	58.7	13.2	41.5	25.1	39 2
5 "	60.3	64.7	17.4	43 3	27.4	42.6
6 "	63.5	64 7	15.1	45.1	26.0	42 9
7 "	54.8	64.7	15.4	46 5	27.6	41 8
8 "	49.6	65.0	16.5	46 3	26.1	40 7
9 "	44.8	60.0	15.3	42.7	26.2	38.0

6. METHOD OF PLANTING.

There is perhaps more diversity of opinion among farmers regarding the best method of planting oats than any other cereal, and when the uncertainty of the season is duly considered, it is after all largely a matter of the quickest way of getting the seed into the ground. A growing custom is to put the seed on the ground and harrow, cultivate, or disk it in. Apparently the results have been satisfactory, and further claim is made that this leaves a better chance for wheat, which follows in the regular rotation of corn, oats, wheat and grass. We have no carefully conducted experiments to prove or disprove this claim, but can testify that the custom does make it much more difficult to plow and prepare the ground for the wheat after the oats crop has been removed.

That the facts might be more definitely determined, an experiment was begun in a small way in 1891, the same work was continued in 1893, putting in eight plots, four each in the two ways. In 1894 the experiment was continued. The results of these three years were given in Table VIII, also the average product from the several duplications of the experiment. Thus far, the plowed land has given higher yields in every instance than where the ground was disked, the average advantage of the plowed land over that which was worked only on the surface having been five bushels per acre. This evidence is not conclusive, but surely is worthy of further work and study. If we are losing five bushels of oats for every acre put out in this haphazard way, the sooner we change our method the better.

It should be added that these experiments were made on clay soil.

OATS.—TABLE VIII—DIFFERENT METHODS OF SEEDING COMPARED.

Method of seeding.	Grain per acre in bushels.			Average.
	1891.	1893.	1894.	
Plot 1. Plowed 6 to 7 inches deep	51.8	55.9	41.7	49.8
Plot 2. Disked 3 to 4 inches deep	46.8	49.0	40.0	45.1
Plot 3. Plowed 6 to 7 inches deep		54.0	44.2	49.1
Plot 4. Disked 3 to 4 inches deep		49.3	38.5	43.9
Plot 5. Plowed 6 to 7 inches deep		56.4		
Plot 6. Disked 3 to 4 inches deep		47.3	41.4	44.3
Plot 7. Plowed 6 to 7 inches deep		54.8		
Plot 8. Disked 3 to 4 inches deep		49.2		
Drilled 1 inch deep	38.1	25.6	29.5	31.0
Drilled 2 inches deep	39.0	31.0	28.7	32 9
Drilled 3 inches deep	35.5	28.4		31.3
Rolled before seeding	43.8		25.4	34.6
Rolled after seeding	42.3		22.0	32.1

Regarding the deep and shallow planting of oats, Table VIII shows, in two years out of three, better results from planting two inches deep than from deeper or more shallow planting. In addition to the better yields per acre, I am of the opinion that oats have stood up better when drilled in two inches and more deep than when they were sown broadcast, or when drilled in about one inch deep; this conclusion, however, can only be a tentative one, as the limited number of experiments will not justify a final decision.

Table VIII gives the result of two years' experiment in compacting the ground both before and after putting in the seed; the first year, 1891, shows that rolling the land either before or after seeding was a decided benefit on that soil and for that season, but the yields of 1894 give results exactly the opposite. The crop of 1891 was grown on the more sandy soil at Columbus, while that of 1894 was grown upon the clay soil of Wayne county. The variation in soil doubtless has had much to do with the outcome in this experiment, but this can only be positively settled by further work upon this particular point.

7. SOME POINTS REGARDING SMUT.

In our last oat bulletin, published in January, 1892, special attention was called to the loss in the oats crop, caused by the presence of smut It was stated in that bulletin that cases were on record where the actual damage by smut had exceeded eighteen per cent.; since that bulletin was issued I have kept records each year with a few of our worst affected varieties, and the results show much more startling percentages than that given above, one variety showing by actual count 34 per cent. of smutted heads.

These figures have been obtained by measuring ten feet on each of eight drill rows, counting the total number of stalks in each, and then counting the smutted heads in each row. The following table gives the percentage of smut in four varieties for four years:

OATS.—TABLE IX—Per Cent. Smutted Heads in Oats for Four Years.

Varieties.	1891.	1892.	1893.	1894.
	Per cent.	*Per cent.*	*Per cent*	*Per cent*
Black Prolific	3.2	2.8	13.3	34.0
American Banner	7.3	4.5	9.7	13 9
Race Horse	5.7	3.9	8.4	19.1
Lincoln	6.4	6.0	12.0	29.0

In addition to the above, countings were made in 1894, showing the following percentages of smut: Seizure and White Wonder, less than 1; Welcome, 1.7; Wideawake, 2.6; Mammoth Russian, 5.9; Great Northern, 20.2; White Superior Scotch, 21.7.

The simplest and cheapest method of destroying the smut is by the Jensen or hot water treatment, given in detail in our bulletin of January, 1892, which is as follows:

This method consists in placing the seed grain in water warmed to about 120 degrees Fahrenheit (the temperature may be 10 or 15 degrees higher in cold weather), taking it out of this as soon as it is thoroughly warmed and placing it in a second bath, the temperature of which should be about 135 degrees. The object of using two baths is to prevent destruction of vitality in the seed, which would occur if the oats were placed in water warm enough to bring the mean temperature of the grain to the heat required to destroy the smut germs. It will be readily seen that if a bushel of oats at the temperature of the atmosphere is introduced into a tub of water heated to 140 degrees Fahrenheit, the oats first coming in contact with the water would be injured by the heat being too great, while the seed going in last would be immersed in water, the temperature of which might be too much reduced to destroy the smut.

A convenient way of conducting this work would be to have two vessels holding twelve to sixteen gallons of water, the temperature of one not exceeding 125 degrees Fahrenheit, the other not exceeding 135 degrees Fahrenheit. Take a basket holding about half a bushel (if this basket could be made of screen wire similar to that used for the fine riddles of a fanning mill, and provided with a cover, it would be the ideal, but in case such a one can not be secured an ordinary splint basket covered with cloth will answer the purpose), fill with oats and dip it into the cooler vessel, turning the basket alternately to right and left, raising and lowering it in the water, so that all the grains may be reached by the water, then immerse immediately in the second vessel in the same way, but keep it in the water from eight to ten minutes.

As soon as it is removed it should be dipped in cold water, or spread out and cold water thrown over it, otherwise the tendency will be to cook some of the grains at least to the extent of destroying vitality. The cooling process concluded, the seed may be left to dry, after which it is ready to be sown.

SUMMARY.

1. In the short, unfavorable season of 1893, the Welcome variety gave lower yields than any other of that class, while the group as a whole gave larger yields than any of the other three.

2. The Seizure oats was the lowest yielder in the whole list for 1893, where sown late, but the same variety sown four to five weeks earlier gave, the same season, as good returns as any other variety on the farm.

3. In 1894, only three varieties in the Welcome group gave higher yields than that variety, namely, Improved American, Badger Queen and Bonanza King.

4. The highest yields in the Seizure group for 1894 were from the following varieties: Japan, Early Swedish, White Swiss, Prince Edward's Island and Wilson's Prolific, the latter variety badly mixed.

5. The highest average yield was decidedly in favor of the Side-oats group.

6. In a series of tests covering four seasons, the varieties that have given the highest average yields are Improved American, Japan, Early Swedish, Prince Edward's Island, State of North Dakota, Colonel, Dakota Gray, Kansas Hybrid, Probsteier and Egyptian.

7. The average weight per measured bushel of all oats grown upon the farm during the last four years falls below the Standard of 32 pounds to the bushel. The highest average for any one variety has been 38.6 pounds, the lowest, 27.3.

8 From the investigations thus far made, it has not been found that oats of heavy weight necessarily have a smaller percentage of hull than those of lighter weight per measured bushel.

9. A single trial indicates that oats put away in good condition shrink but very little—in this instance less than one per cent.—and the straw under ordinary conditions shrinks about 6 per cent.

10. Experiments extending over three seasons on our clay soil show that the method of putting in oats without first plowing the ground may involve a loss of five bushels per acre as compared with sowing on land that has been plowed and well prepared.

BULLETIN

OF THE

Ohio Agricultural Experiment Station.

NUMBER 58. December, 1894.

METEOROLOGICAL SUMMARY FOR 1894.

BY C. A. PATTON.

EXPLANATION OF TABLES.

The following tables contain statistics of temperature, rainfall, etc., for the year, and are compiled from data obtained by daily observations. T stands for "trace," less than .01 inch of daily rainfall. Temperature is given in degrees Fahrenheit.

Table I. shows the daily rainfall at the Station during the year in inches and hundredths.

Table II. shows the daily mean temperature for 1894, and the normal mean temperature for each day, computed from seven years' record.

Table III. gives a comparison of the monthly mean temperature and rainfall for the Station and the State, with the ten and twelve years' average for the same.

Table IV. shows the rainfall for the Station for each month during the last seven years.

Table V. contains the mean temperature, the highest and lowest temperatures, with the range of temperature, for each month; the number of clear, fair and cloudy days; the rainfall and prevailing direction of wind, for both the Experiment Station and State, for 1894.

Table VI. contains the principal points of interest on temperature, state of weather and rainfall for the Station during the year, and a grand summary for seven years.

Table VII. contains the principal points of interest on temperature, state of weather and rainfall for the State during the year and a grand summary for twelve years.

The statistics for the State and for this Station, previous to 1893, are compiled from the publications of the Ohio Meteorological Bureau and

State weather service, the seven-year average being computed from the observations of the Wooster Station of the Ohio Meteorological Bureau, which Station was located two miles north of the present site of the Experiment Station, but at nearly the same altitude:

METEOROLOGY—TABLE I.—RAINFALL.

DAILY RAINFALL AND MELTED SNOW FOR 1894 AT EXPERIMENT STATION.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1	....	.15	....	....	.02	.15	....	.30	....	....	....	.40
2	....	....	....	....	....	....	....	T	....	....	....	.07
3	....	....	....	T	....	....	....	....	....	.31	.25	....
4	.15	.05	....	.23	.20	T	....	....	....	.01	T	....
5	....	....	....	.05	.48	T	....	....	.10	.13	.20	....
6	.42	....	.24	....	.02	....	.30	....	....	....	.55	....
7	....	.05	....	.12	.10	....	....	....	.25	....	.34	.12
8	....	.40	.07	....	....	....	....	....	.30	....	.15	.20
9	....	.70	....	....	....	....	....	T	....	....	.20	....
10	....	....	....	46	.03	....	....	T	.55	.06	.08	.60
11	....	....	....	.02	.03	....	....	T	....	....	....	.04
12	....	.75	....	....	....	.01	....	.24	....	T	....	.55
13	....	.10	....	....	....	....	.30	....	.65	.25	.07	....
14	....	.05	....	....	.16	....	.04	T	T	.11	T	....
15	.60	.15	.42	....	T	....	....	....	.31	....	....	....
16	.02	....	....	....	.43	.03	....	....	.72	....	.02	.03
17	....	.50	....	....	.75	.02	....	....	....	....	.02	....
18	.11	.45	....	....	.09	.02	....	....	.55	....	....	....
19	....	.02	.21	.12	.13	.05	....	.22	.35	....	....	....
20	....	....	....	.02	.12	....	T	....	.02	....	....	....
21	.19	....	.07	.13	.30	....	.30	....	....	....	....	T
22	....	....	.80	.25	.40	....	....	....	T	.20	....	....
23	....	....	.15	....	.09	T	.43	....	.27	T	.03	....
24	.20	....	....	....	.21	.26	01	....	....	.20	....	.23
25	....	....	.02	....	T	.02	T	T	....	....	....	.01
26	....	....	....	....	.17	.46	....	....	....	....	....	.30
27	....	....	....	....	....	.05	....	....	....	....	....	.60
28	....	....	....	.25	.25	.02	....	....	....	....	....	....
29	.50	....	.33	09	.06	1.14	T	T	....	....	....	....
30	....	....	....	....	.26	....	....	....	....	1.20	.50	....
31	....	....	.05	....	.11	....	....	....	....	06	....	....
Totals	2.19	3.37	2.36	1.74	4.41	2.23	1.38	.76	4.07	2.53	2.41	3.15
Averages	.07	.13	.08	.06	.14	.07	.04	.02	.14	.08	.08	.10

METEOROLOGY—TABLE II.—TEMPERATURE.

N Stands for Normal Mean Temperature for Seven Years.

	January.		February.		March.		April.		May.		June.		July.		August.		September		October.		November.		December.	
	1894.	N.	1894.	N.	1894	N.	1891	N.	1891.	N.	1894.	N.	1891.	N.	1891.	N.	1894.	N.	1894.	N.	1894.	N.	1894.	N.
1.	33	39.4	28	32.6	49	30.5	43	47.9	62	52.4	50	60.6	76	69.3	76	70.2	65	62.8	53	56.9	49	49.6	40	30.7
2.	39	31.8	16	31.4	43	30.0	36	44.9	66	53.5	56	63.2	76	70.9	75	70.8	7	64.0	58	54.4	51	49.6	30	31.2
3.	40	24.9	34	30.3	38	31.0	40	47.5	57	54.1	62	65.3	71	68.0	64	71.5	69	65.7	67	59.0	50	41.8	32	34.6
4.	48	31.3	20	28.9	48	28.2	54	46.6	66	51.9	62	63.6	70	65.6	60	68.4	77	68.8	51	53.7	41	39.7	26	29.8
5.	46	32.4	10	27.4	55	26.4	44	46.0	60	53.4	50	6 .7	66	6 4	60	69.2	73	66.6	48	51.6	40	41.4	31	32.8
6.	40	32.3	28	27.2	56	31.0	40	42.4	68	51.7	48	62.0	62	68.0	66	68.9	75	64.9	52	50.1	34	4 .3	34	33.0
7.	29	25.5	35	29.8	40	31.5	46	47.4	59	53.3	54	58.9	55	69.5	73	69.3	78	65.1	50	50.0	28	44.9	35	33.4
8.	24	25.6	4	26.7	41	36.3	40	46.6	58	57.1	58	6 .7	62	70.7	71	72.4	78	66.3	50	47.9	34	44.4	48	36.7
9.	28	24.7	52	28.1	42	34.8	35	42.9	56	61.5	66	66.8	60	67.1	8	73.6	78	66.2	46	50.9	33	47.4	40	34.8
10.	34	24.7	39	28.9	45	35.6	41	44.8	66	61.2	70	69.3	63	68.6	73	70.4	70	65.5	41	49.7	34	41.0	34	36.2
11.	33	28.3	28	28.2	47	39.1	38	44.8	58	57.4	72	65.6	77	70.7	67	68.0	56	64.7	48	51.6	25	39.5	50	35.6
12.	22	27.7	26	24.5	40	37.0	41	46.9	58	55.7	76	65.8	79	72.4	78	67.3	60	65.7	46	51.9	24	39.6	46	32.3
13.	30	26.3	24	28.4	44	34.5	43	49.7	5	54.6	70	67.9	78	72.8	72	65.8	71	63.5	48	50.4	33	40.8	36	32.4
14.	41	26.1	2	31.4	41	29.4	5	44.1	64	55.3	70	70.0	72	72.2	68	65.7	77	64.3	42	45.2	35	39.4	38	33.5
15.	41	23.8	22	27.2	44	30.5	52	43.2	62	59.4	73	72.8	69	71.1	63	68.2	74	66.6	41	47.3	40	40.5	44	3 .6
16.	42	23.5	18	32.8	48	32.7	53	47.2	64	53.5	75	73.6	71	68.8	60	69.3	64	61.4	54	4 .5	49	41.6	48	39.2
17.	46	25.1	28	35.4	52	36.7	59	52.4	70	57.3	74	72.6	76	71.2	62	68.4	60	59.3	57	50.7	34	38.1	40	34.3
18.	45	26.6	34	32.8	58	38.7	59	51.3	62	63.4	74	72.7	77	69.9	73	69.3	69	60.9	47	49.2	9	35.5	33	29.9
19.	36	23.1	29	30.0	55	39.4	65	51.2	44	54.9	66	70.5	78	69.4	72	68.7	62	62.3	58	49.8	29	35.2	34	30.9
20.	42	24.8	24	27.4	58	42.6	51	49.5	46	54.8	66	71.0	74	67.0	68	68.7	63	60.0	64	47.3	30	34.4	39	31.0
21.	39	22.8	19	26.4	61	41.5	46	50.6	46	55.8	70	72.0	69	68.1	66	67.9	63	60.5	63	47.9	43	39.9	40	33.1
22.	32	24.4	20	28.0	55	36.7	49	47.8	49	57.4	75	72.1	68	71.5	62	61.9	66	63.7	62	47.3	42	38.1	39	34.5
23.	30	31.2	22	30.5	43	38.6	51	51.2	48	55.0	77	71.4	64	69.3	68	63.9	67	62.9	55	46.8	42	33.3	31	34.6
24.	28	28.3	10	33.4	42	38.3	55	45.8	53	60.1	76	71.0	74	69.6	72	66.9	52	60.2	55	47.1	35	33.4	34	37.1
25.	8	27.0	17	32.5	28	36.9	53	45.8	57	59.6	74	69.2	76	71.2	76	69.2	48	58.3	51	46.7	29	33.0	32	38.5
26.	15	28.2	32	29.2	22	38.7	58	52.7	60	56.1	78	69.6	78	71.9	71	69.4	31	55.7	50	47.2	30	31.6	26	31.1
27.	17	25.7	29	29.7	21	35.5	56	55.1	61	57.4	74	6 .0	76	71.0	69	67.1	56	54.5	52	43.3	45	27.3	16	25.5
28.	23	27.5	41	31.8	29	33.3	69	56.5	54	57.2	72	68.4	76	72.4	66	64.4	64	55.3	53	43.0	30	29.7	6	26.8
29.	32	30.0	....	....	29	35.3	68	54.7	47	58.9	71	69.8	78	73.9	70	64.3	66	54.1	50	42.5	24	30.9	4	29.5
30.	24	29.4	....	....	30	39.3	74	56.3	50	62.5	74	70.3	74	71.5	68	64.9	68	55.7	55	43.1	35	30.9	17	26.0
31.	30	34.0	....	....	41	45.8	....	....	52	61.8	....	....	72	73.8	63	61.1	....	....	41	45.1	....	....	16	31.4
Mean	32.8	27.5	26.7	29.7	43.5	36.5	50.5	45.1	57.5	57.0	67.9	69.3	71.4	70.0	69.2	67.9	66.1	62.2	52.1	48.9	36.5	38.8	32.9	32.9

Having no readings for August 1891, 15-31, Inc., and February, 1892, 9-22, Inc., the readings were taken from Ashland Station, which is about 22 miles west of Wooster, and has the same latitude, within one minute, and the same elevation, within 16 feet, of the Station, at which the Wooster observations were taken previous to 1892.

METEOROLOGY—TABLE III.

MEAN TEMPERATURE AND RAINFALL FOR THE STATION AND STATE, 1894. TEMPERATURE IN DEGREES FAHRENHEIT, RAINFALL IN INCHES.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
Mean temperature at the Station, 1894	32.8	26.7	43.5	50.5	57.5	67.9	71.4	69.2	66.1	52.3	36.5	32.9	50.5
Ten years' average temperature at the Station	25.8[1]	29.0[1]	30.8[3]	47.4	57.3	68.8	70.8	67.6[1]	62.6	50.0	38.7	32.4[1]	50.0
Mean temperature for the State, 1894	33.7	28.9	45.1	50.6	60.0	71.3	74.3	71.2	67.8	53.9	37.5	33.9	52.3
Twelve years' average temperature for the Station	26.8[2]	31.1	36.1	50.0	59.6	70.1	73.0	70.1	64.5	51.8	40.3[4]	32.6[4]	50.9
Rainfall at the Station, 1894	2.19	3.37	2.36	1.74	4.41	2.23	1.38	0.76	4.07	2.53	2.41	3.15	30.60
Ten years' average rainfall at the Station	2.54	4.09[1]	2.74[3]	2.31[3]	4.20[3]	4.25[3]	3.40	2.35[1]	3.03	2.78	3.03	2.75	34.79
Rainfall for the State, 1894	2.14	2.79	2.16	2.21	4.00	2.65	1.56	1.67	3.31	2.01	2.17	2.93	29.75
Twelve years' average rainfall for the State	3.02	3.87	2.79	3.02	4.55[2]	3.98	3.22	3.07	2.94	2.57	2.99[4]	2.50[4]	38.21

[1] Nine years. [2] Ten years. [3] Eleven years. [4] Thirteen years.

METEOROLOGY—TABLE IV.

MONTHLY RAINFALL FOR SEVEN YEARS AT WOOSTER.

	January.	February.	March	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
	Inches.	*Inches.*	*Inches*	*Inches*	*Inches*	*Inches.*	*Inches*	*Inches*	*Inches*	*Inches.*	*Inches.*	*Inches*	*Inches*
1888	3.52	2.43	3.34	2.48	3.82	2.30	4.54	4.38	1.92	3.18	4.95	1.39	38.23
1889	4.33	2.42	2.13	1.58	2.97	4.85	6.73	1.98	4.05	1.36	3.53	3.93	39.87
1890	4.71	6.20	4.57	3.10	6.01	5.57	2.67	4.66	5.12	7.45	2.61	1.74	54.21
1891	2.74	4.83	3.71	1.66	2.24	7.13	3.28	1.85	0.94	1.33	5.73	2.92	38.36
1892	2.67	....	3.38	2.44	7.69	7.89	4.73	2.69	3.20	0.37	2.06	1.74	38.86
1893	4.01	6.33	1.89	5.66	6.28	2.51	1.38	1.53	1.85	5.18	2.48	1.50	40.61
1894	2.19	3.37	2.36	1.74	4.41	2.23	1.38	0.76	4.07	2.53	2.41	3.15	30.60
Averages	3.45	4.26	3.05	2.67	4.77	4.64	3.53	2.55	3.02	3.06	3.40	2.34	40.11

METEOROLOGY—TABLE V.

SUMMARY BY MONTHS FOR 1894.

	Temperature.											Number of days.						
	Mean.	Highest.	Date.	Lowest.	Date.	Range.	Mean daily range.	Greatest daily range.	Date.	Least daily range.	Date.	Clear.	Fair.	Cloudy.	Rain fell.	Monthly rainfall.	Average daily rainfall.	Prevailing wind.
At the Station.																		
January	32.8	56	5th	1	25th	55	16	33	13th	5	16th	14	8	9	8	2.19	.07	N.W.
February	26.7	64	9th	—1	20th	65	18	35	2d	7	11th	10	13	5	12	3.37	.12	N.W.
March	43.5	75	18th	14	27th	61	24	41	17th	7	25th	10	19	2	10	2.36	.08	S.W.
April	50.5	92	30th	24	3d	68	24	42	18th	6	11th	12	15	3	11	1.74	.06	N.W.
May	57.5	83	*1	35	29th	48	24	40	26th	7	21st	3	18	10	22	4.41	.14	N.W.
June	6[illegible].9	93	23d	37	6th	56	27	40	8th	13	5th	12	18	......	12	2.23	.07	N.W.
July	71.4	98	19th	41	7th	57	29	45	31st	10	21st	16	14	1	6	1.38	.04	N.W.
August	69.2	96	9th	41	*2	55	31	43	22d	11	19th	18	12	1	3	.76	.002	S.W.
September	66.1	93	7th	36	*3	57	26	44	3d	17	19th	14	9	7	11	4.07	.14	S.E.
October	52.1	80	2d	28	18th	52	24	42	19th	5	5th	12	11	8	11	2.53	.09	S.W.
November	35.8	65	2d	31	*4	52	18	42	29th	7	8th	3	7	20	12	2.41	.08	N.W.
December	32.9	57	11th	—7	28th	64	14	25	28th	4	*5	3	10	18	12	3.15	.10	S.W.
Sums and averages	50.5	79.3	....	21.8	.. ..	55.8	22.9	39.6	....	8	....	127	154	84	130	30.60	.08	N.W.
For the State.																		
January	33.7	66	5th	—16	25th	82	18	49	24th	2	9th	10	10	11	8	2.14	.07	S.W.
February	28.9	76	9th	—15	5th	91	18	51	28th	1	7th	8	9	11	9	2.79	.10	S.W.
March	45.1	91	20th	3	26th	88	23	53	3d	2	23d	11	11	9	8	2.16	.07	S.W.
April	50.6	97	30th	16	3d	81	23	54	16th	2	11th	11	8	11	10	2.31	.08	S.W.
May	60.2	93	14th	31	29th	67	23	52	9th	3	19th	8	12	11	10	4.00	.13	S.W.
June	71.3	102	23d	29	6th	73	27	55	22d	3	28th	15	12	3	8	2.65	.09	S.W.
July	74.3	105	19th	36	9th	69	27	51	11th	2	26th	17	12	2	5	1.56	.05	S.W.
August	7[illegible].2	104	9th	36	4th	68	23	56	7th	4	24th	15	12	4	5	1.67	.05	S.W.
September	67.8	103	5th	27	26th	76	25	57	1st	3	18th	14	11	5	8	3.31	.11	S.W.
October	53.9	90	20th	15	15th	75	24	60	19th	1	30th	13	10	8	8	2.01	.07	S.W.
November	37.5	79	2d	4	12th	75	19	49	29th	1	*1	8	10	12	9	2.17	.07	S.W.
December	33.9	70	8th	—27	29th	97	16	53	31st	1	*2	8	9	14	9	2.98	.10	S.W.
Sums and averages	52.4	90	....	11.6	....	78.5	22.6	53.3	....	2	....	138	126	101	97	29.75	.08	S.W.

Station—*1 14th, 17th. *2 25th, 22d. *3 26th, 27th. *4 12th, 29th. *5 1st, 23d. State—*1 5th, 7th. *2 13th, 23d.

METEOROLOGY—TABLE VI.

SUMMARY BY YEARS AND GRAND SUMMARY FOR SEVEN YEARS.

	1888.	1889.	1890.	1891.	1892.	1893.	1894.	Summary for seven years.
At	Wooster.	Wooster.	Wooster.	Wooster.	Wooster.	Experiment Station.	Experiment Station.	
Mean temperature	47.6°	48.6°	49.5°	50°	50°	49.3°	50.5°	49.3°.
Highest temperature		91.50° [*1]	94.5°, Aug. 3	99°, Aug. 8	98°, July 25	95° [*5]	98°, July 19	99°, August 8, 1891.
Lowest temperature	- 5°, Feb. 9	—5° [*2]	1°, March 7	0°, March 1	—20°, Jan. 20	—9°, Jan. 11.	—7°, Dec. 28	—20°, Jan. 20, 1892.
Range of temperature		96.5°	93.5°	99°	118°	104°	105°	119°.
Mean daily range of temperature		18.7°	18.9°	21°	19°	202°	22.9°	20.1°.
Greatest daily range of temperature		42°, April 23	41°, Jan. 13	42°, Sept. 23	46°, July 7	45°, Aug. 9	45°, July 31	46°, July 7, 1892.
Least daily range of temperature		2°, January 6	4 5° [*3]	4°, Feb. 8	4°, [*4]	30°, [*6]	4°, Dec. [*7]	2°, Jan. 6, 1889.
Number of clear days		125	109	116	116	96	127	115.
Number of fair days		103	119	110	123	164	154	129.
Number of cloudy days		137	137	125	98	105	84	114.
Number of days rain fell		119	149	119	119	129	130	127.
Total rainfall	38.25 inches	39.87 inches	54.21 inches	38 36 inches	38.86 inches	40.58 inches	30.60 inches	40.14 inches.
Greatest monthly rainfall	4.51 inches	6.73 in., July	7 45 in., Oct	4.26 in., June	7.89 in., June	6.33 in., Feb	4.41 in., May	7.89 in., June, '92.
Least monthly rainfaall	1.39 inch	1.36 in., Oct	1.74 in., Dec	1.95 in., April	0.87 in., Oct	1.38 in., July	0.76 in., Aug	0.37 in., Oct., 1892.
Prevailing direction of wind	S	S	S	S	S.W	S.W	N.W	S.

[*1] July 10, September 1. [*2] February 23 and 24. [*3] January 8 and September 10. [*4] March 5, November 1, 3 and 25, December 1 and 18. [*5] July 7 and 25, September 7. [*6] January 24, February 11, May 26. [*7] December 1 and 23.

METEOROLOGY—TABLE VII.

SUMMARY BY YEARS AND GRAND SUMMARY FOR TWELVE YEARS FOR THE STATE.

	1883.	1884.	1885.	1886.	1887.	1888.	1889.
Mean temperature	49.4°	50.6°	48.0°	49.6°	51.4°	49.5°	51.1°.
Highest temperature	98°, August 22	99.0°, Sept 28, Oct. 1	101.0°, July 21	98.6°, July 7	108.0°, July 18	102.0°, Aug. 3	99 5°, Aug. 31.
Lowest temperature	17.2°, January 22	—34.0°, Jan. 25	—31.0°, Jan. 29	—21.5°, Jan. 12	—21.0°, Jan. 7	—15.0°, Jan. 27	—13 5°, Feb. 24.
Range of temperature	115.5°	133.0°	132.0°	120.1°	129 0°	117°	113.0°.
Mean daily range of temperature	19.8°	20.5°	20.4°	20.2°	21 2°	19 6°	19.3°.
Greatest daily range of temperature	55.2°, March 18	50.0°, Sept. 5, Dec. 4	58.5°, Jan 30	57.0°, Dec. 11	57 0°, April 11	50.0°	53.0°, March 30.
Least daily range of temperature	0.5°, Dec. 23	1.1°, Feb. 6	1.0° Apr. 18, Dec. 31	1.1°, March 27	1.0°, Jan. 5, Apr. 16	1.2°, Jan. 16	1.0°, Jan. 5.
Average number of clear days	98.2	116.7	103.5	118.4	113 8	108.7	112.8.
Average number of fair days	135.4	118.3	132.8	125.7	127 3	123.4	113 8.
Average number of cloudy days	130 4	131.1	128.2	121.0	123 9	133.9	138.4.
Average number days rain fell	146 0	145 0	147.7	130.7	120.9	124.7	114.8.
Mean yearly rainfall	44.98 inches	40.19 inches	38.08 inches	36 71 inches	33.63 inches	39 64 inches	33.53 inches.
Mean daily rainfall	0.123 inch	0.110 inch	0.104 inch	0.100 inch	0.092 inch	0.108 inch	0.92 inch.
Prevailing direction of wind	S.W	S.W	S.W	S.W	S.W	S.W	S.W.

METEOROLOGY—TABLE VII.—Concluded.

	1890.	1891.	1892.	1893.	1894.	Summary for twelve years.
Mean temperature	52.4°	52°	50°	50.10	52.40	50.60.
Highest temperature	103.1°, August 3	101°, August 10	103°, July 25	102°, June 19	105°, July 18–19	108°, July 18, 1887.
Lowest temperature	—4.0°, March 7	—5°, March 5	—25°, January 20	—24°	—27°, December 29	—34°, Jan. 25, 1884.
Range of temperature	107.1°	106°	1 8°	126°	132°	133°.
Mean daily range of temperature	19°	20°	19°	21.7°	23°	20 3°.
Greatest daily range of temperature	49.5.°, April 11	50°, April 27 & 30	51°, September 25	54 6°	60°, October 19	60°, Oct. 19, 1894.
Least daily range of temperature	1 0°, December 17.	2 [*1]	1° [*2]	1°	1°, February 7	0.5°, Dec. 23, 1883.
Average number of clear days	103.4	133	111	122	138	115.
Average number of fair days	121.6	109	126	123	126	124.
Average number of cloudy days	140.3	137	129	120	101	128.
Average number of days rain fell	149.4	120	121	113	100	128.
Mean yearly rainfall	50.33 inches	38.61 inches	37.16 inches	39.63 inches	29.75 inches	38.52 inches.
Mean daily rainfall	0 138 inch	0.11 inch	0.10 inch	0.11 inch	0.08 inch	0.105 inch.
Prevailing direction of wind	S. W.	S. W.	S. W.	S. W.	S. W.	S. W.

[*1] January 4 and 11, March 19 and 22, November 12, December 4.
[*2] July 29, November 3, 12 and 28, December 17.

NOTES ON THE WEATHER AT THE STATION—SUMMARY BY MONTHS.

JANUARY.

The mean temperature was 32.8°, which is 7° above the nine year Station average for January. The highest temperature, 56°, occurred on the 5th; the lowest, 1°, on the 25th.

Clear weather prevailed. Rain and snow fell on eight days. The total precipitation was 2.19 inches, which is 0.35 inch below the Station average for January.

The prevailing wind was northwest.

FEBRUARY.

The mean temperature was 26.7°, which is 2.3° below the Station average for February. The highest temperature, 64°, occurred on the 9th; the lowest, —1°, on the 20th.

Fair weather prevailed. Rain and snow fell on twelve days. The total precipitation for the month was 3.37 inches, which is 0.72 inch below the Station average for February.

The prevailing wind was northwest.

MARCH.

The mean temperature was 43.5°, which is 12.7° above the Station average for March. The highest temperature, 75°, occurred on the 18th; the lowest, 14°, on the 27th.

Fair weather prevailed. Rain and snow fell on ten days. The total precipitation for the month was 2.36 inches, which is 0.38 inch below the Station average for March.

The prevailing wind was southwest.

APRIL.

The mean temperature was 50.5°, which is 3.1° above the Station average for April. The highest temperature, 92°, occurred on the 30th; the lowest, 24°, on the 3d.

Fair weather prevailed. Rain and snow fell on eleven days. The total precipitation for the month was 1.74 inch, which is 0.57 inch below the Station average for April.

The prevailing wind was northwest.

MAY.

The mean temperature was 57.5°, which is 0.2° above the Station average for May. The highest temperature, 83°, occurred on the 10th and 17th; the lowest, 35°, on the 29th.

Fair weather prevailed. Rain fell on twenty-two days. The total rainfall for the month was 4.41 inches, which is 0.21 inch below the Station average for May.

The prevailing wind was northwest.

JUNE.

The mean temperature was 67.9°, which is 0.9° below the Station average for June. The highest temperature, 93°, occurred on the 23d; the lowest, 41°, on the 7th.

Fair weather prevailed. Rain fell on twelve days. The total rainfall for the month was 2.23 inches, which is 2 03 inches below the Station average for June.

The prevailing wind was northwest.

JULY.

The mean temperature was 71.4°, which is 0.6° above the Station average for July. The highest temperature, 98°, occurred on the 19th; the lowest, 41°, on the 7th.

Clear weather prevailed. Rain fell on six days. The total rainfall for the month was 1.38 inch, which is 2.02 inches below the Station average for July.

The prevailing wind was northwest.

AUGUST.

The mean temperature was 69.2°, which is 1.6° above the Station average for July. The highest temperature, 96°, occurred on the 9th; the lowest, 41°, on the 5th and 22d.

Clear weather prevailed. Rain fell on three days. The total rainfall was 0.76 inch, which is 1.59 inch below the Station average for August.

The prevailing wind was southwest.

SEPTEMBER.

The mean temperature was 66.1°, which is 3.5° above the Station average for September. The highest temperature, 93°, occurred on the 7th; the lowest, 36°, on the 26th and 27th.

Clear weather prevailed. Rain fell on eleven days. The total rainfall for the month was 4.07 inches, which is 1.04 inch above the Station average for September.

The prevailing wind was southeast.

OCTOBER.

The mean temperature was 52.3°, which is 2.3° above the Station average for October. The highest temperature, 80°, occurred on the 2d; the lowest, 28° on the 18th.

Clear weather prevailed. Rain fell on eleven days. The total rainfall for the month was 2.53 inches, which is 0.25 inch below the Station average for October.

The prevailing wind was southwest.

NOVEMBER.

The mean temperature was 36.5°, which is 2.2° below the Station average for November. The highest temperature, 65°, occurred on the 2d; the lowest, 13°, on the 12th and 29th.

Cloudy weather prevailed. Rain fell on twelve days. The total rainfall for the month was 2.41 inches, which is 0.62 inch below the Station average for November.

The prevailing wind was northwest.

DECEMBER.

The mean temperature was 32.9°, which is 0.5° above the Station average for December. The highest temperature, 57°, occurred on the 11th; the lowest, —7°, on the 28th.

Cloudy weather prevailed. Rain and snow fell on twelve days. The total precipitation for the month was 3.15 inches, which is 0.40 inch above the Station average for December.

The prevailing wind was southwest.

INDEX.

(Articles marked * are illustrated.)

PAGE
Acknowledgments XVIII
Agriculturist, report of XXII
Board of Control, report of VII
Botanist, report of XL
Cattle, selection of XXIII
Crops of the year XIII
Chemist, report of XLIII
Dairyman, appointment of VIII
Dairy, the XXIII
Director, report of XIII
Donations to the Station XVIII
Entomologist, report of XXIX
Farm products XXV
Feeding experiment XXIII
Fertilizers, field experiments with 1
  " plan of distribution 2
  " on wheat grown continuously 3
  " relative increase of grain and straw *8
  " on oats grown continuously 11
  " on corn grown continuously 13
  " on wheat grown in rotation 15
  " on oats grown in rotation 17
  " on corn grown in rotation 19
  " on clover and timothy in rotation 20
  " on co-operative tests in corn 21
  " on corn in Columbiana county 22
  " " Butler county 25
  " " Washington county 28
  " field experiments in Wayne county 32
  " source of phosphoric acid in 31
Horticulturist, report of XXVI
Insects—
  Agrilus ruficollis XXIX
  Amblynotus iowensis XXXIX
  Apenteles XXXVI
  Aphidius chenopodiaphidis XXXVI
  Bag worm .... *XXXII
  Blissus leucopterus XXXIII
  Brochymena annulata XXXV
  Bucculatrix pomifoliella XXXVI
  Chenopodium album XXXVI
  Chinch bug XXXIII
  Cirrospilus flavicinctus XXXVI
  Clover-leaf weevil .... *XXXVIII
  Clover-root worm .... *XXXVII
  Corimelæna pulicaria XXXVI

Insects—Concluded— PAGE
Crioceris asparagi xxxi
Diabrotica longicornis *xxxi
Elachistus ohioensis *xxxvi
Elasmus nigrescens xxxix
Erycus puncticollis xxxv
Euonymus atropurpureus xxxix
Eulophus tricladus xxxix
Fidia viticida xxx
Fidiorba flavipes *xxx
Flavescent clover weevil xxxvi
Gouty-gall beetle xxix
Grape-root worm xxxi
Gryllotalpa borealis *xxxiv
Habrocytus aulacis xxxix
Harpiphorus maculatus xxxiv
Hemerobius occidentalis xxxix
Hoplophora arctata xxx
Hylesinus trifolii xxxvi
Isocratus vulgaris *xxxvi
Lasius brunneus xxx
Limothrips tritici xxxiii
Listronotus appendiculatus xxxv
" *latiusculus* xxxv
Lysiphlebus salicaphus *xxxix
Microgaster xylinoides xxxix
Negro bug xxxvi
Nematodes on roses xxvii
Northern mole cricket xxxiv
Onion thrips xxxiii
Pachyneuron aphidivora xxxix
Pear blister beetle xxxiv
Phorbia fusciceps xxxiv
Phytonomus punctatus xxxvi
Pomphopœa œnea xxxiv
Potato stalk borer xxxvi
Praon coloradensis xxxix
Rhaphitelus maculatus xxxix
Rhodites spinosa xxxix
Sagittaria curculio *xxxv
San José scale *81
Scolytus rugulosus xxxix
Seed-corn maggot xxxiv
Segnipiesis nigrifemora xxxix
Sitones flavescens xxxvi
Spilochalcis torvina xxxix
Strawberry worm xxxiv
Thyridopteryx ephemeræformis xxxii
Tischeria malifoliella xxxix
Trichobaris trinotata xxxvi
Tyroglyphus phylloxeræ xxx
Western Corn Root-worm xxxi
White maggot xxxiv
Meteorologist, report of 117
Oats—Comparison of varieties 97, 101

PAGE

Oats—four-year average yield 105
" weight per bushel 107
" percentage of hull and kernel 108
" shrinkage of grain and straw 111
" distribution of seed 111
" method of planting 113
" points regarding smut 114
Phosphoric acid, source of in fertilizers 31
Plants identified XLI
Publications, summary of XV
Russian thistle (see thistle).
San José scale, the *81
" introduction of 85
" spread of 85, 89
" on California fruit 86
" life history of 87
" varieties of fruit infested 90
" natural enemies of 91
" remedies for 91
Season, the XIII
Sheep, selection of XXIV
Station's work, the XIII
Strawberries, soil and location for 35
" preparation of soil for 26
" fertilizers for 36
" when to set plants 36
" how far apart to set 38
" methods of training 38
" how long to keep in bearing 38
" treatment of old beds 39
" winter protection for 39
" removal of mulch 40
" propagating from seeds 40
" selection of varieties 41
" notes on varieties 42
Straw, ratio of to grain 6
Sub-irrigation in the green-house XXVII
Sub-stations XV
Thistle, Russian, in Ohio *53
" seeds of 55
" origin and history of 55
" manner of dissemination 56
" probable character in Ohio 56
" publications concerning 57
" remedies and suggestions 57
Treasurer, appointment of VIII
" report of IX
Weed laws, Ohio 62
" Wisconsin 64
" South Dakota 65
Weeds, what is a weed? 59
" classification of 59
" in grass seeds 60
" along highways 61

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